Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

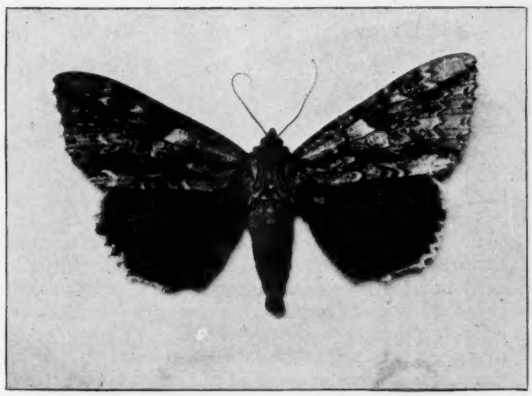
VOL. I. No. 3. [NEW SERIES.] APRIL, 1904. [Entered at Stationers' Hall.] SIXPENCE.

Contents and Notices.—See Page VII.

The Protective Resemblance of Insects.

By PERCY COLLINS.

THE story of insect life has many phases of entrancing interest; nor is this altogether surprising when we remember that the earth, the air, and the water are alike peopled by the vast army of the six-footed. These varied conditions of life have left their mark not only upon the habits and movements of insects, but upon their colour, their form, and their instinctive attitudes of repose. So that although insects are more diverse than any other natural group of living creatures, the explanation is simple; they are and have been subjected to almost every condition under which life is known to be possible. Thus, to the entomologist, every difference of form, colour, or attitude seems worthy of serious investigation. He realises that an unusual tint or a quaint pattern carries with it a definite meaning—that it is in some way linked to the ancestral history of its possessor. Often enough this meaning is mysterious. But occasionally the colours and form of an insect, or of a group of insects, can be explained as the direct outcome of certain known influences. Not infrequently such interpretations reveal the fact that the shape or colour of an insect, or both in combination, are mainly responsible for its well being. The creature's peculiar appearance either mystifies its enemies or enables it to approach unobserved the smaller insects upon which it preys. The whole subject, to which the general term "mimicry" is commonly applied, constitutes one of the most fascinating phases of entomological study.



Catocala sp. Japan.

The simple protective resemblance of an insect may be either general or special. That is to say, the protection may originate in the mere likeness of an insect's surface colouring to that of its customary surroundings, or it may consist in an actual reproduction in both form and colour of a certain object with which the creature is commonly associated throughout its life.

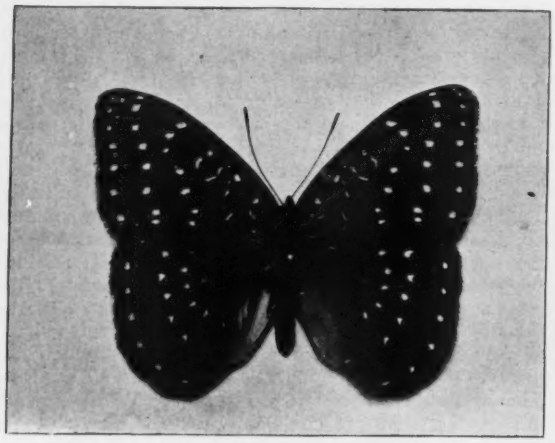
Instances of general protective resemblance must be familiar to observers in all countries. The numerous moths which are accustomed to rest for hours together upon rocks or tree trunks are oft-cited examples. Conspicuous among them is the whole genus *Catocala*, the various species of which are widely distributed in the Palæarctic region and elsewhere. These moths have brightly coloured hind wings, the usual tint—which has given to them their popular title of "Red-underwings"—being some shade of crimson or pink. When they are on the wing they are sufficiently conspicuous, and are liable to be snapped up by a hungry bird. But when at rest upon a tree trunk in their customary attitude of repose, the soft grey or brown colour of their fore wings produces a general effect so well in keeping with the

Catocala sp. Japan. At rest on bark.

rough surface of the bark, that they are extremely difficult to detect. Their colour pattern alone constitutes a most effectual hiding.

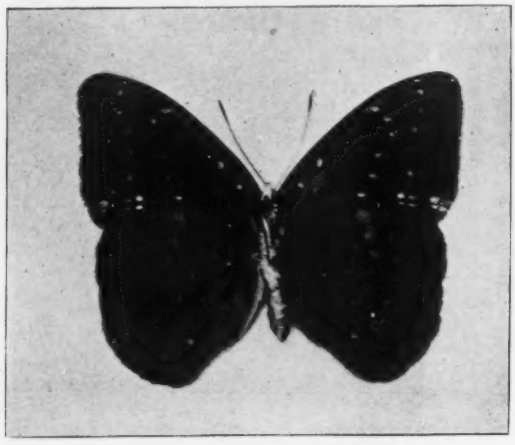
The same may be said of countless other moths, especially of the great *Noctua* group; and it is interesting to trace how closely the colour of the fore wings in a given species corresponds to its habitual resting place. The appearance of all kinds of bark, of mossy twigs and of lichen-covered rocks is faithfully reproduced; nor is it necessary to search beyond the moths of our own islands for striking examples.

Many butterflies, especially of the great group *Nymphalinæ*, possess—in the tints of their under side—a general resemblance to the ground upon which they habitually



Hamanumida dedalus. Africa.

settle. Moreover, many species seem to have acquired the trick of inclining their folded wings out of the perpendicular, by this means covering, or minimising, their own shadow, as well as bringing the protectively coloured underside into more prominent view. This habit may be observed in many of our common "brown" butterflies—for instance, in *Pyrarga megaera* and in *Satyrus semele*. In connection with this apparently acquired aid to protected resemblance, the habits of *Hamanumida dedalus*, an African butterfly, are exceedingly interesting. It is authoritatively stated that this insect rests in West Africa with its wings folded over its back after the



Hamanumida dedalus. (Underside.) Africa.

common habit of butterflies, in which position its tawny under surface, which agrees with the general tone of the soil, is exposed to view. In South Africa, on the other hand, the same insect sits with its wings expanded, showing the brownish grey upper side which harmonises with the colours of the rocks in that region.

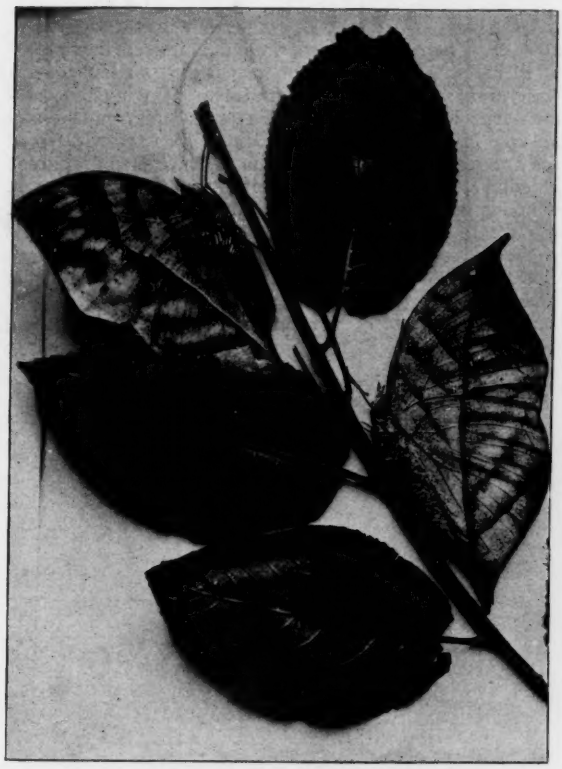
Many of the *Coleoptera*, from their colour, are almost indistinguishable when resting upon lichen-incrusted bark. The accompanying photograph of a *Longicorn* from Bhutan admirably illustrates this phase of general protective resemblance. Although the insects are in full view, the casual glance quite fails to detect their presence. This surprising result is largely gained by the manner in which the colour is, as it were, cut up into dark and light patches. This is particularly noticeable in the long antennæ, the sharp outline of which is entirely effaced from their being coloured in alternate lengths of black and grey.

Turning from general to special protective resemblance, we find a number of extremely interesting and remarkable examples, especially among exotic insects. The butterflies of the genus *Kallima*—"leaf butterflies," as they are popularly called—bear striking testimony to the

Apaliuna ducalis. Male and Female. Bhutan. On Lichenous Bark.

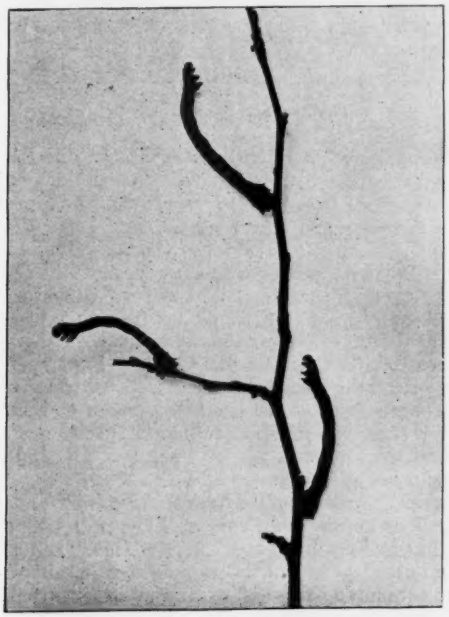
powers of natural selection. When flying in the full sunlight, their wings flash with colour, but directly they come to rest upon a twig they are, to all appearances, brown and withered leaves. This sudden transformation is made possible by the tinting of the under surface of the wings, and by the curiously erect attitude which the insect is able to assume—its wings drawn upright over the back and its head and antennæ concealed between their anterior margins. When we consider the marvellous accuracy of the colour imitation, the uncommon shape of the insect's wings and its unusual pose, the leaf butterfly must still be ranked as one of the most amazing instances of protective resemblance yet recorded, notwithstanding the many marvels which have been brought to our notice within recent years.

The larvæ of moths grouped under the title *Geometridæ* usually bear a curiously accurate resemblance to little twigs or sticks, both in shape and in their brown



Kallima niachis. India. Two Specimens at rest among leaves.

or grey colouring. Moreover, this deception is materially heightened by the unique attitude of repose obtaining among these caterpillars, which differ from most lepidopterous larvæ in possessing only two instead of five pairs of pro-legs. These are placed at the extreme posterior end of the body, while the three pairs of true legs at the other extremity are usually exceedingly diminutive. The perfect stick-likeness is gained in the following manner. The caterpillars of the *Geometridæ* usually feed at night, When daylight comes, or under the stimulus of alarm. they take a firm hold upon the twig with their four pro-legs and stretch out their cylindrical body stiff and straight at an acute angle. In this position they are capable of remaining, absolutely motionless, for hours together. But to counteract the terrible strain which the attitude would impose upon the body of the caterpillar, each usually spins a strong, though practically invisible silken thread from its mouth to the twig on which it rests.



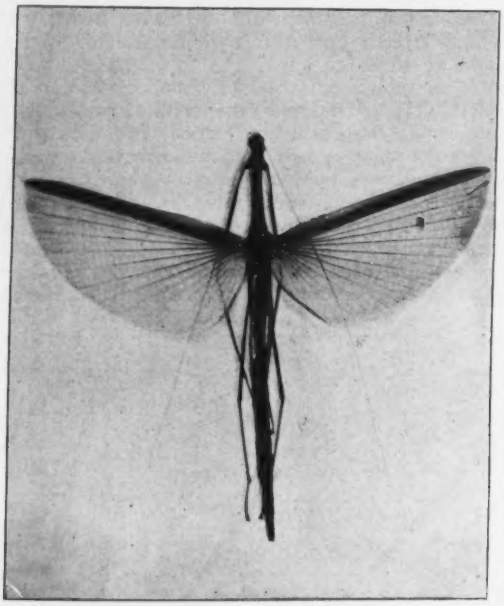
Three Caterpillars of **Hemerophila abruptaria.** England

A family of insects remarkable above all others for the almost universal protective resemblance of its members is the *Phasmidæ*. In order to understand these creatures, which are numerous in all tropical countries, it is necessary to know something of their habits. Unlike their near relatives, the *Mantidæ* or "praying insects," which are voracious insect eaters, the *Phasmidæ* are exclusive vegetarians, feeding greedily upon the leaves of the plants which form their resting places. In movement, Phasmids are extremely sluggish, and many of the species—being apterous or possessing, at most, only rudimentary wings—are incapable of flight. Thus, they are much exposed to the attacks of birds and other insectivorous creatures—have been so, in all probability, for ages past. This persecution might be supposed to foster any variation in shape or colour likely to be of protective value. And, as a matter of fact, the whole of the *Phasmidæ*, almost without exception, have undergone striking modifications in the direction of special resemblance.

Clitumnus Sundaicus. Stick-like Phasmid.

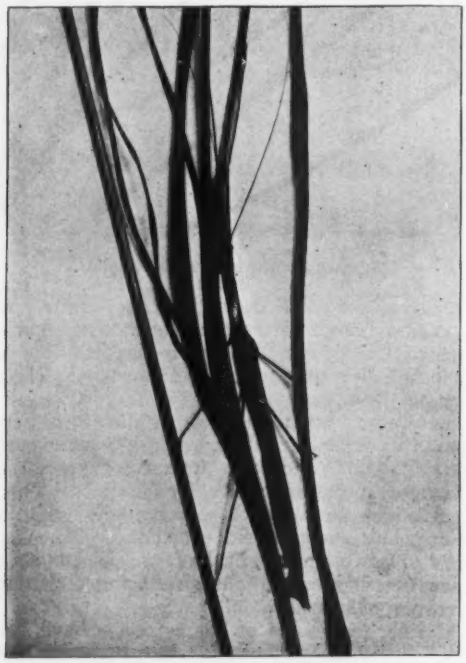
As a rule, the bodies of these insects have become greatly lengthened, while the legs are long and slender. Those known popularly as "walking sticks," of which the *Clitumnus sundaicus* shown in the accompanying photo-

graph is a good example, are generally of a uniform brown tint. Many of the species have curious knotty protuberances, or even prickles, upon their bodies and legs, this, of course, adding much to the stick-like aspect



Winged Phasmid, showing two portions into which each wing is divided.

of the insect. After examining a dried specimen of a "stick" Phasmid, one does not need the assurance of foreign collectors to believe that these creatures are practically invisible when at home among the branches of their native shrubs.



Winged Phasmid, at rest among grass blades.

Other *Phasmidæ*—fairy-like creatures with exquisitely coloured wings—resemble grass rather than twigs when at rest. Their bodies, legs, antennæ, indeed every part of them, with the exception of certain portions of the wing area, is green. Their first pair of wings is rudimentary; but their hind wings are ample, gauzy, and fan-like in their manner of folding. A narrow strip at the anterior margin of each wing is thickened and green in colour, contrasting strangely with the gauzy area, which is usually bright pink. Under this narrow cover, the whole of the bright, flimsy portion of the wing is packed away when the insect comes to rest. And so closely are the wings folded that the casual observer imagines the creature to be apterous. It is, indeed, the exact counterpart of a crumpled or slightly-thickened grass blade, while its legs and antennæ are too slender to attract much notice.

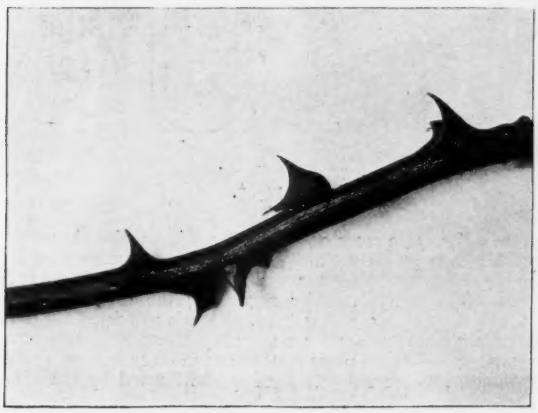
Phyllium *sp.* Female. Ceylon.

Perhaps the most remarkable genus of the *Phasmidæ* is *Phyllium*, whose members—unlike the majority of their allies, which we have seen to be slender and lengthened—have the body and legs flattened into leaf-like plates. In some instances this design of leaf resemblance is carried out with amazing accuracy and attention to detail. Every portion of the insect seems modified to the one end. Its body is flat and leaf-like; its wings and wing cases (where present) look like leaves; while even its legs are flattened and fitted with leaf-like appendages. To crown all, the colour of these insects, when alive, is the brightest and freshest of vegetable greens; so that, when crawling among herbaceous foliage, a species of *Phyllium* is, to all appearances, not an insect at all, but just a moving mass of leaves.

Certain species of the *Membracidæ*, which are rather small, frog-hopper-like insects, have a most curious thorn-like or knot-like appearance. This is gained by an unusual development of the pronotum, which is produced behind into a long process, or, it may be, into a kind of shield. In the case of *Umbonia spinosa*, from Brazil, this

process extends completely over the insect, and is drawn upwards to a point. In fact, it is an exact imitation of a sharp vegetable thorn, from which it is indistinguishable. Thus, the *Umbonia* has merely to crouch down upon a thorny twig and withdraw its legs beneath the shield-like pronotum to be completely hidden.

The above examples include some of the more striking instances of protective resemblance, both general and special. They must not, however, be regarded as even typically exhaustive, for sticks, leaves, mosses, and lichens, though common patterns, are by no means the only objects copied in insect colour and form. Flowers, seed pods or seeds, patches of mould or decay—even the droppings of animals and birds are all prototypes for insect disguise. Moreover, the modifications of form and the varieties of colour and marking which have been called into being by the need for protection are too



Umbonia spinosa. Brazil. (Middle "thorn" on upper part of Stem).

numerous even to tabulate. In the course of his investigations, every observant student will constantly have new and striking instances brought to his notice, even though he may never wander beyond the confines of his own county.

But it should be recollected that to form a true estimate of the protective value of an insect's colour and form, it is absolutely essential to study them in relation to their habitual surroundings; for, as a rule, it is quite impossible to tell from a casual examination whether a special appearance is protective or not. A butterfly in a cabinet drawer is merely a scientific specimen. Its colours may be bright and beautiful, dull and unattractive, as the case may be; but suspended above a surface of white paper, they have no special significance. On the other hand, when the insect is alive and among its natural surroundings, its colour and shape are often seen to have a direct bearing upon its well-being. Thus the study of living specimens cannot be too strongly urged upon the student—not of entomology alone, but of every branch of natural history.

A RATHER unexpected geographical discovery has been made by M. Gabriel Marcel, who in a Paris shop found an Eighteenth Century map on which is shown the project put forward by M. de la Bastide for a canal across the American isthmus by the Nicaragua route. The map, which is finely executed, is printed on silk, and from its shape was clearly intended for the decoration of a fan. It shows three ships in sail on the Lake of Nicaragua, and marks the suggested route to the west of the lake. Though M de la Bastide's project is a matter of geographical history—he wrote a memoir on it in 1791—the map's existence had been hitherto unsuspected. His was a plausible project, but he did not by any means realise its difficulties, for he was a theorist who never visited the spot, and who depended on the very inaccurate maps of other people.

Professor Adam Sedgwick.

The Man and his Work.

WHEN, just over 30 years ago, at a meeting held in the Senate House, Cambridge, the idea was first mooted of a memorial to Professor Adam Sedgwick, it was said of him in the words of Shakespeare, "His life was gentle; and the elements so mixed in him that Nature might stand up and say to all the world, This was a man."

It is well at this moment, when the Sedgwick Museum is an actual commemoration, to recall the up-bringing and achievements of the subject of this splendid allusion.

The son of a Yorkshire clergyman, Sedgwick, at the close of his early education, proceeded to Trinity College, Cambridge, duly took a degree, and was classed as 5th Wrangler. In 1810 he was made a Fellow of his College, and engaged in teaching; and in 1816 was ordained. But it was not as a divine that his repute became established, but as a leader in British geology, a soldier in the early campaigns of the science. Elected Woodwardian Professor of Geology in 1818, although knowing, we are told, comparatively little of the study he was to teach, it seemed as if he was predestined for its successful prosecution, and it was not long before he stepped into the front rank as an original investigator. His lectures, which formed a novel feature when he entered upon the duties connected with the Woodwardian Chair, attracted general attention, while at the same time the Professor lost no opportunity of promoting and encouraging the extension of natural science teaching in the curriculum of university studies. Those were early days in geology—in fact, the long-clothes stage—and the authorities looked askant at the iconoclastic science, mindful, too, of what it might bring in its train. Undoubtedly, in the case of many other men, efforts to obtain the recognition of geological and allied studies would have been foredoomed to failure in the face of the frowning repressiveness which prevailed at Cambridge. But Sedgwick was endowed with special qualities for the task in hand, and never deviated from the chosen path. Moreover, his charming personality and adornments of character disarmed permanent opposition. Of these characteristics there is ample testimony in the opinions of his contemporaries. Three prominent hopes possessed his heart in the earliest years of the Professorship, in his own words expressed thus:—"First, that I might be enabled to bring together a collection worthy of the University, and illustrative of all the departments of the science it was my duty to teach; secondly, that a Geological Museum might be built by the University, amply capable of containing its future collections; and, lastly, that I might bring together a class of students who would listen to my teaching, support me by their sympathy, and help me by the labour of their hands." The fulfilment of these hopes is, of course, a matter of history.

Sedgwick was the author of a lengthy series of papers in British geology, but he wrote no separate work. In particular is he known for his elucidation of the Palæozoic system, in which he collaborated with Murchison. He investigated the Magnesian Limestone of the North of England, and the geology of Wales engaged his earnest and successful study. He was elected a Fellow of the Royal Society in 1821, and in 1863 was awarded the envied Copley medal – a year previous to the award

XUM

made to Darwin—for his observations and discoveries in the Palæozoic series of rocks, and more especially for his determination of the characters of the Devonian system. Other honours were showered upon him, both at home and from abroad, including, in the former category, the Presidency of the Geological Society and of the British Association.

As a contemporary of Darwin, Professor Sedgwick was confronted with that naturalist's theory respecting the evolutionary order of Nature. His attitude was uniformly hostile to the hypothesis, and he would have none of it. In this connection it is interesting to note that, at the time of the publication of the "Origin of Species," Darwin was exceedingly sore at the "rabid indignation" displayed by Sedgwick, nevertheless he took occasion to refer in affectionate strain to the veteran geologist's noble heart and instincts.

Sedgwick never married. He continued his occupancy of the professorial chair until his death, in 1873, which took place at the ripe age of eighty-eight, and he was buried in the ante-chapel of Trinity College.

Finally, let these words of his further proclaim the man: "My labour is its own reward. It gave me health, and led me into scenes of grandeur which taught me to feel in my heart that I was among the works of the great Creator."

Telegraphically Transmitted Photographs.

By DR. ALFRED GRADENWITZ.

MANY attempts have been made to transmit handwriting, photographs, drawings, &c., by telegraphic means, and the more or less successful solutions which have been suggested for this problem of late years are numerous. Selenium cells, as shown by Herr Ruhmer's successful experiments in the field of wireless telephony, give a ready means of detecting and transmitting by telephone even very slight fluctuations in the intensity of a source of illumination, and afford means of converting these fluctuations into oscillations of an electric current. If a light ray and a selenium cell be simultaneously drawn along over opposite sides of a photographic plate, the different shades of the various portions of the plate will result in continuous oscillations of the current being produced in the circuit of the cell. This is a common feature with all the sending devices used in the instruments of this class. The current oscillations are made to act on the receiving apparatus, which will reconvert them in turn into fluctuations of light. The design of the receiving apparatus has hitherto been the weak point with all these systems, because the electric currents transmitted are so very small. But a satisfactory solution of the difficulties so far met with seems to be afforded by the teleoptical apparatus of Professor Arthur Korn, Munich, as recently presented before the French Academy of Sciences.

While engaged in investigating the radiations given off by the electrodes of a tube exhausted to a pressure ranging between 0·2 and 2 mm. as Hertzian vibrations were applied to the electrodes, Professor Korn noticed the extreme sensitiveness with which these radiations would react on small alterations in the circuit. This sensitiveness suggested a possible utilisation of those radiations which were photographically most efficient, in connection with a method of electrical telephotography.

The apparatus, based on the above principle, is shown in fig. 1.

The photographic film *a* of the receiver rotates in front of a small window *c* (0·25 mm × 0·25 mm) in an exhausted tube *b*, like a roller, in front of the vibrating membrane of a phonograph. The surface of the tube is coated with black paper and tin-foil, leaving only the window. By means of high frequency currents (Tesla currents), luminous radiations may be produced inside the tube, and these, after passing through the small window, will make photographic impressions on the sensitive film. The latter is moved synchronously with the image-holder A of the sending-apparatus (a film bearing the photograph to be transmitted wound on a glass cylinder), which is traversed by a very thin beam of light B C D while passing, line per line, before a selenium cell D placed inside the cylinder. According to the different shades in the photograph transmitted, the sele-

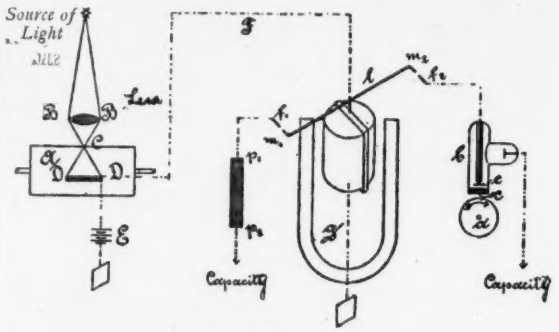
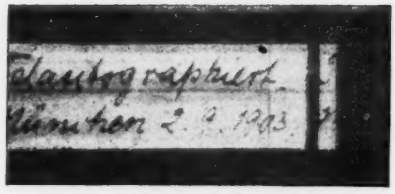


Fig. 1.

nium will receive more or less light, while an electric current, passing through the selenium D and the telegraphic wire F up to the receiving apparatus, will undergo corresponding variations of intensity, thereby regulating the intensity of the radiations of the receiving tube. This is provided for in the following way: The active electrode *e* of the tube being connected to one of the poles *p*, of the secondary coil of a Tesla apparatus, by inserting fields of sparks formed by the points

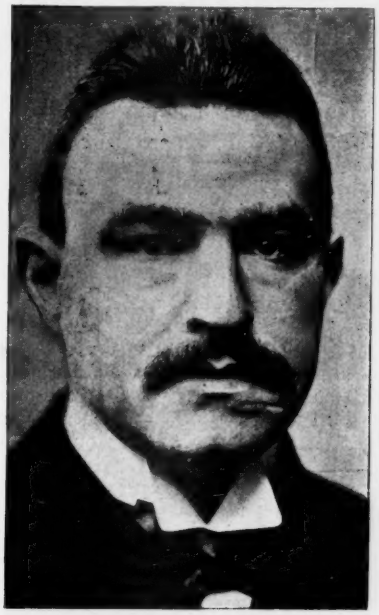
Original Photograph.



Transmitted Photograph.

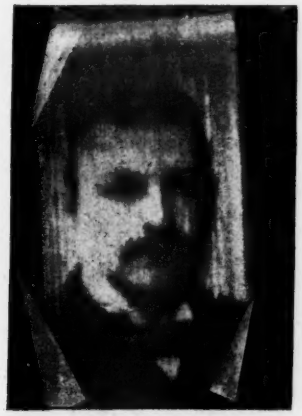
m_1, m_2, of a galvanometer needle *l* and two fixed points f_1, f_2, the intensity of the radiations given off by the tube will be more or less great, according to the distances m_1 f_1 and m_2 and f_2, which are variable along with the transmitted currents passing through the galvanometer *g*. By the use of this arrangement, a means is afforded of making the intensity of the radiations of the receiving tube correspond with the intensity of the light striking the selenium of the sending-apparatus, thus reproducing line per line of the original photograph.

The telephotographic receiver may, as well, serve as a telautographical receiving-apparatus, *i.e.* an apparatus for reproducing handwriting, drawing, &c., at great distances. In this case, only some very slight alterations will have to be made, and a Bakewell-Caselli transmitter used. The speed attained is relatively very high. It has been found possible to reproduce from twenty to forty words in the



Original Photograph.

original handwriting in the course of three minutes, and in the case of shorthand much higher speeds may be arrived at. The transmission of photographs, of course, is slower, principally on account of a certain inertia of the selenium. The progress lately made in connection with the construction of selenium cells, however, makes much higher speeds very probable. The time at present required for telephotographing a portrait is about half-an-hour.



Transmitted Photograph.

Figs. 2 and 3 show the telegraphic reproduction of a photograph and a telautographic specimen respectively. The inventor wishes us to state that part of the imperfections of the photo, especially the stripes, is due to the experiments having been made in the Physical Laboratory of the Munich University, where the pressure of the battery and, accordingly, the intensity of the source of light, would undergo frequent fluctuations.

Modern Views of Chemistry.

By H. J. H. Fenton, F.R.S.

In our last communication we indicated very briefly, in outline, the nature of the ionic-dissociation hypothesis, and mentioned some of the experimental facts upon which it is based ; we propose now to give a few illustrations of the manner in which the hypothesis has been applied to the explanation or interpretation of some well-known chemical and physical facts.

What is an acid? Everyone who is at all acquainted with the elementary facts of chemistry has a fairly clear conception in his own mind what the term implies, but attempts to frame an exact definition are not always satisfactory. If an acid is "any hydrogen compound which can exchange its hydrogen, wholly or partly, for a metal when the latter is presented to it in the form of a hydroxide," we must include as acids substances such as zinc hydroxide and aluminium hydroxide, the distinction between acid and base being relative rather than absolute. It was at one time proposed to restrict the term "true acid" to a compound which can behave in the above manner even in presence of much water, and such a restriction would, it is true, exclude substances like zinc hydroxide, but it would also exclude some compounds like silicic acid which are looked upon as acids. Other definitions, such as "a salt of hydrogen," "a compound which can evolve water by its action on caustic potash," or "a compound of hydrogen with an electro-negative element or group," can generally be found fault with, and there is often a tendency to define the terms "acid," "salt," "base" in a circle.

The ionic-dissociation hypothesis now comes to the rescue with an elegant and simple definition. An acid, it says, is a compound whose aqueous solution contains free hydrogen ions. What we call acidity or acid-property in a solution is due to these ions, and is more pronounced as their concentration is greater, *i.e.*, the more there are in a given volume. A base, on the other hand, is a compound whose aqueous solution contains free hydroxyl (O H) ions, and when an acid neutralises a base the only change which takes place (provided the solution is dilute and the acid and base are "strong") is the union of the free hydroxyl and hydrogen ions to form water. It will be observed that, according to this conception of the matter, neither the metal or acid radicle takes any part in the change ; they remain as free ions throughout—

$$H + R + M + O H = M + R + H O H$$

(where R is the acid radicle and M the metal).

It must not be forgotten that the older definitions alluded to above are practical ones, whereas this ionic definition depends entirely upon hypothesis ; the latter, however, affords a remarkably simple explanation of many well-known facts. When, for example, equivalent weights of strong acids (say, hydrochloric or nitric) neutralise strong bases (say, caustic potash or soda), the quantity of heat evolved is always the same. This fact is easily understood on the above supposition, since in each case the only change in the arrangement is the union of hydroxyl with hydrogen.

If the acid or base, or both, are not "strong," the heat change on neutralisation will be different from that in the previous case. This is explained by saying that the weaker acids and bases are not entirely in a state of

"ionisation" or dissociation to begin with, and require to be further broken up before the hydrogen and hydroxyl can combine.

What exactly is to be understood by the *strength* of an acid or a base was for a long time the subject of dispute. It used to be said that sulphuric acid was stronger than hydrochloric or nitric acids, because it "turned them out" from their combinations with bases. Sodium nitrate, for example, when distilled with sulphuric acid, gives sodium sulphate and free nitric acid. The test of strength, however, when applied in this manner, is not legitimate, since the nitric acid is not given a fair chance; it is removed from the sphere of action by vaporisation. A much more rational way of arranging the encounter was that devised by Thomsen when he mixed, in dilute solution, one equivalent weight of each acid with one equivalent weight of base. Here there is insufficient base to satisfy both acids, and all the substances concerned, before and after the action, remain dissolved together without any removal. The two acids then strive for the base, and the one which gets most of it is the "strongest." In this way it is possible to arrange the acids in the order of their "strength," and experiment showed that hydrochloric and nitric acids head the list in such an arrangement.

Sulphuric acid proves to be only about half as strong as nitric or hydrochloric acids—a result altogether at variance with the older ideas.

The problem has been attacked also from various other points of view: it is known, for example, that the salts of weak acids or weak bases may undergo what is called hydrolysis in aqueous solution, that is to say that

$$\text{Salt} + \text{water} = \text{acid} + \text{base}.$$

Such an action can easily be shown in the case of ferric chloride or sodium borate. It was proposed, therefore, to classify acids as weaker or stronger according to the extent to which their salts were "hydrolysed" by water under similar conditions.

Again, there are many chemical changes which are found to be greatly accelerated by the presence of acids, and if these changes happen to be sufficiently slow to enable one to map out the rate of change, it is possible to compare the influence of different acids. Results obtained in such ways agree, on the whole, remarkably well with the order of "strength" as measured by the "striving for base" method.

The electric conductivity again was found to be better for the stronger acid; and the same is true with regard to the deviation from the "normal" osmotic pressure above referred to (Article I.). Such observations were largely instrumental in leading up to the new theory. If one "believes in ions,"* it is a comparatively simple matter to explain, in terms of the hypothesis, what is meant by the "strength" of an acid. The strongest acids, like nitric and hydrochloric acids, undergo complete, or nearly complete, ionisation when dissolved in a moderate volume of water, whereas the weaker acids, like acetic or hydrofluoric acids, are ionised to a less extent. In other words, a moderately diluted solution of hydrochloric acid contains a (relatively) large number of free hydrogen ions in a given volume, and an equivalent quantity of acetic acid contained in the same volume gives rise to (relatively) few free hydrogen ions.

But ionisation increases as dilution increases, so that we arrive at the conclusion, which sounds paradoxical at first, that when their aqueous solutions are infinitely diluted all acids would be equally "strong"!

The strength of an acid, then, depends, according to these ideas, upon the concentration of the free hydrogen ions which is attained when an equivalent weight of the acid is dissolved in water and the solution made up to a given volume. But how are we going to measure this, or compare it, say, in the case of two given acids?

The complete explanation of the way in which this can be done would perhaps be out of place in a brief sketch like the present one; we will merely attempt here to give a very rough indication of the principle.

The electric conductivity of an acid in solution depends upon the number of free ions present in a given volume and upon the speed with which they move. If we determine (directly or indirectly) the molecular conductivity of a given acid (1) when the solution is moderately dilute, and again (2) when it is infinitely dilute, it can easily be shown that the first number divided by the second will tell us the extent to which the acid is ionised in the moderately dilute solution. We can then make similar experiments with other acids under the same conditions, and so compare the extent to which each is ionised. Assuming for simplicity that each acid splits up into two ions, one of which, of course, is hydrogen, it is evident that the one which is most ionised is the strongest under the given conditions, *i.e.*, there will be more free hydrogen ions in a given volume of solution.

The extent of ionisation of the acid can also be arrived at from other considerations, such as the deviation from the normal osmotic pressure (see Article I.); but the electric conductivity method is the most generally applicable.

* At the present time it is well to look upon this ionic explanation as a very efficient and complete working hypothesis, and not to regard it, as is often done, in the light of a creed or dogma.

The Problem of Cancer

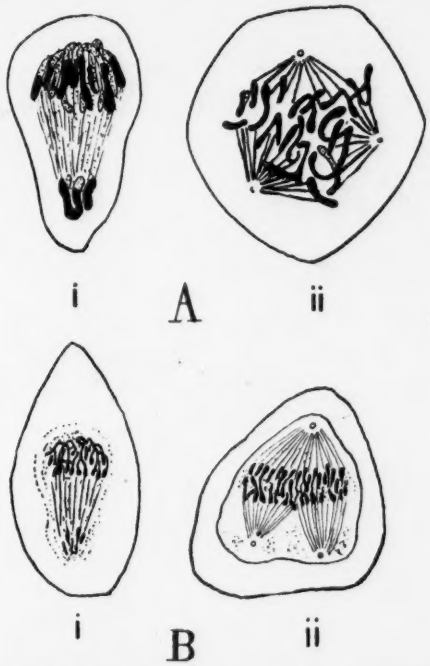
By FELIX OSWALD, B.A., B.Sc.

THE failure of bacteriologists to discover a cancer-bacillus has facilitated future investigation regarding a probable cure for cancer by narrowing the issue and disposing of a fruitless line of research. On the other hand, the recent important discovery of Professor Farmer and his colleagues, that cancer-cells agree with reproductive cells in only containing half the number of chromosomes in the nucleus after nuclear division, recalls the experiments of Galeotti,* in 1893, with regard to the unsymmetrical and irregular nuclear division in cancer-cells. It appears probable that the efficacious preventive treatment of cancer is to be sought in the direction indicated by these experiments, which have hardly received the attention they deserve. Briefly stated, Galeotti treated actively dividing, epithelial cells of salamanders with dilute solutions of drugs such as antipyrin, chloral, quinine, cocaine, nicotine, potassium iodide, &c. The action of these substances caused asymmetrical and tripolar division of the nucleus, exactly similar—as the accompanying figures will show—to the asymmetrical and tripolar division which takes place in cancer-cells in a human subject. The remarkable similarity between these pathological occurrences

* Beitr. zur patholog. Anatomie und zur allgem. Pathologie, XIV. 2; Jena, 1893.

points to the inevitable conclusion that cancer is primarily due to an irritant poisonous substance, that such substance is secreted in a spot liable to disease, *e.g.*, in glandular tissue, and that the blood is unable to carry off or neutralise the deleterious matter.

The problem of an ultimate cure for cancer would seem, therefore, to lie in the chemist's sphere rather than the surgeon's, *viz.*, firstly, in the careful analysis of fresh cancerous tissue, and the isolation of the irritant principle; and, secondly, in the discovery of an antidote to be injected into the system just as antitoxin is injected for diphtheria, to assist the blood in its function of eliminating the injurious substance. It is a suggestive fact that antagonistic drugs are known to the substances which Galeotti used in creating the pathological nuclear divisions so



A.—Epithelial Cells of Salamander, showing (i.) unsymmetrical nuclear division after treatment with 0·05 per cent. antipyrin solution; (ii.) tripolar division after treatment with 0·5 per cent. potassium iodide solution. B.—Human Cancer Cells, showing (i.) unsymmetrical, and (ii.) tripolar nuclear division. [Both after Galeotti.]

similar to those of cancerous tissue, *e.g.*, strychnine is antagonistic not only to nicotine, but to chloral, to which atropine also shows antagonism.

The similarity between cancer-cells and reproductive cells in containing only half the usual number of chromosomes compared to normal somatic cells, and the further discovery that the nuclei of *all* the cells in the sexual generation (prothallus) of a fern show this reduction, would seem to indicate that the occurrence of cancer-cells in the bodies of man and higher animals shows a tendency to a reversion to the remote state of things when every single cell of the reproductive generation partook of this peculiarity of the reproductive cell. It would be interesting in this respect to ascertain whether the cells of the sexual generation in lowly creatures of the animal kingdom, such as liver-flukes, jelly-fish (*Aurelia*), and some Tunicates (*Salpa*), &c., which exhibit an alternation of sexual and asexual generations, show the same condition as the fern prothallus in the vegetable kingdom.

Rare Living Animals in London.

By P. L. SCLATER, F.R.S.

IN the annual reports of the Zoological Society of London will always be found a section containing a list of the species new to the collection exhibited during the preceding year, and though, as we all know, it is continually becoming more difficult to find "something new" in any class of objects, it will be seen, on reference to the reports, that even in the most recent years the list of novelties is by no means a short one. There are, in fact, always a considerable number of recent additions to the Zoological Society's living collection of much interest, and well worthy of representation by the facile fingers of the artist, which we believe to be a much more generally effective way of bringing the points of their shape and structure into notice than the cheaper and more fashionable photographs of the present day.

It is with great pleasure, therefore, that I have undertaken to write a few remarks on some of the rare and interesting animals in the Regent's Park that have lately formed the subjects of Mr. Goodchild's skilful pencil.

1. The Thylacine.

(Thylacinus cynocephalus.)

In the late Sir William Flower's excellent "Introduction to the Study of Mammals" the threefold division of that order, originally proposed by Blainville, into "Ornithodelphia," "Didelphia," and "Monodelphia" is fully maintained, although, for good reasons, Huxley's change of these names into "Prototheria," "Metatheria," and "Eutheria" is adopted, as being "far less open to objection." The Metatheria, as Flower points out, are represented in the present epoch by numerous species which offer considerable diversities in appearance, in structure and in habits, although they all agree in many anatomical and physiological characters which give them an intermediate position between the Prototheria and the Eutheria. The most important of the latter set of characters is that the young of the Metatheria are brought forth in a rudimentary condition, and are nourished by milk injected into their mouths from the maternal mammæ, to which they are firmly attached for some time after their birth. During this process the young, in nearly all cases, are sheltered in an abdominal pouch or *marsupium*, whence the Metatheria have received the more familiar name of "Marsupials."

The Marsupials then, as we will call them, are usually divided into two sections, the Diprotodonts and the Polyprotodonts. Of the former of these, which with a few unimportant exceptions are vegetable feeders, the best known are the kangaroos of Australia and the adjacent islands, while of the Polyprotodonts, which are carnivorous and insectivorous, the finest and largest representative now living on the earth's surface is the Thylacine of Tasmania, the animal represented in the accompanying drawing.

On first seeing the Thylacine alive the uninformed spectator would naturally take it for a dog or a wolf. And indeed in general external appearance the Thylacine is excessively like one of these animals, but it is, nevertheless, undoubtedly a Marsupial in every essential part of its structure, and like most other members of the

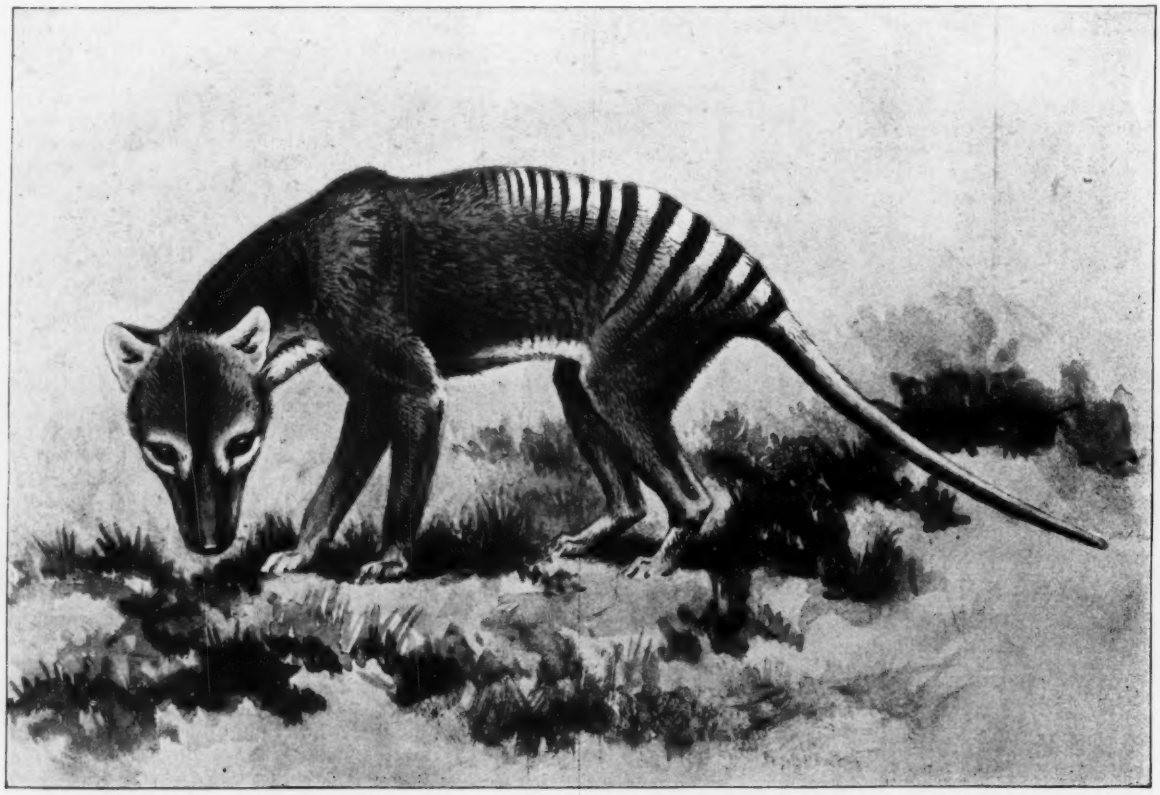
XUM

Metatherian group carries its new-born young in an abdominal pouch. It is also at once distinguishable from a wolf by its long, tapering, and thinly-haired tail, as is well shown in our picture, and by the curious transverse stripes on the back, which are very prominent in the living animal.

The Thylacine is a native of Tasmania, and is not found in any other part of the world, although in a former geological epoch an allied form, which has been named *Thylacinus spelæus* by Professor Owen, existed in the adjacent parts of Australia. In Tasmania the Thylacine is said to be popularly known as the "tiger" or "hyæna," from its rapacious habits, but is also often called, more appropriately, the "Tasmanian wolf."

In former days, when Tasmania was first peopled by Europeans, the Thylacine was common in all the rocky and mountainous districts of the island, and at that time found an abundant supply of food in the native kangaroos and bandicoots. But when sheep were introduced into the Colony, and bred in large numbers, the Thylacine soon learned to attack the sheepfolds, and consequently became an object of persecution to the Tasmanian shepherds, whose fierce hostility has now brought it to the verge of extinction. Of late years, indeed, very few living specimens of it have reached Europe, and the Zoological Society is fortunate in having secured the fine young male example now figured, which was obtained by purchase in March, 1902. So far as I know, this is the only specimen of the Thylacine now alive in Europe.

The first living Thylacines ever received by the Zoological Society were a young pair presented by their Corresponding Member, Mr. Roland Gunn, of Launceston, in 1849. They had been captured in snares on the upper branches of St. Patrick's River, about thirty miles N.E. of Launceston, and lived many years in the Regent's Park. The same generous friend, learning that these animals were no longer alive, sent a second pair in 1863, which likewise did well in the Society's Gardens. Thylacines in captivity are very active in their movements when excited, but somewhat nocturnal in their habits. They are usually fed on mutton.



1. **The Thylacine** (*Thylacinus cynocephalus*).

Blake's Historical Charts.

MR. WILLIAM BLAKE has compiled a series of Historical Charts, designed to show in a sort of bird's-eye view the course of English History in different year periods. Chart No. I. gives a general view of English History from 1066 to 1902. Chart No. II., intended to be used with the other Charts, and a most useful supplement to them, gives contemporary European rulers from 1066 to 1902. Succeeding Charts cover various phases of English History from the Roman Dominion in Britain to the reign of Queen Victoria. The Charts have been very carefully compiled at the cost of immense labour, and are designed for the use both of students and teachers.

The Ancestry of the Carnivora.

By R. Lydekker.

Compared with the more advanced types of ungulate, or hoofed, mammals, such as the horse, the camel, and the true ruminants, all the Carnivora are in many respects much less specialised animals, more especially as regards the structure of their limbs. By this I mean that although all of them are thoroughly adapted to their own special mode of life, while in many instances they are some of the most active, most highly organised, and most intelligent of all animals, yet they depart much less widely from the primitive type of mammals in general than is the case with the more specialised ungulates, or indeed, than ungulates collectively. In none of them for instance, does the number of toes on each foot ever fall below four, while in some cases the typical five digits are retained in at least one pair of feet. Then again, although in the members of the cat tribe specialisation is displayed by the development of sheaths for the protection of the sharp and sickle-like claws, the terminal joints of the toes are always of the primitive claw-like type—the unguiculate form, as it is termed by naturalists, and never make any approach to either nails or hoofs. Moreover, all the Carnivora are characterised by the absence of that tendency to a reduction of the number of the bones in the limbs by the fusion of two together and the disappearance of others, which, as we have seen, form such striking features in the evolution of the more specialised types of hoofed animals. Such consolidations and reductions in the bony framework are indeed strictly correlated with and necessary to the development of a small number of hoofs on each foot, and are, therefore, from the very nature of the case, conspicuous by their absence in the Carnivora. Indeed, if we except the frequent disappearance of the collar-bones, or clavicles, the skeleton shows none of that amalgamation or loss of some of its elements, coupled with the excessive development of others, which are such noticeable features in the more specialised ungulates.

Then, again, the teeth of the Carnivora, though admirably adapted to the special needs of their owners, are much less widely removed in structure from the primitive, or generalised, mammalian than are those of the higher hoofed mammals. The cheek-teeth, for instance, never display that heightening or broadening of the crown, coupled with those deep infoldings of the grinding surface, seen in the molars of the horse and the ox. Moreover, unlike what so frequently takes place in the ungulates, the front teeth are always well developed, and rarely fall below the typical mammalian number of three pairs of incisors and one of canines, or tusks, in each jaw. Indeed, when a reduction in the number of the teeth does take place, as in the cats, whose short jaws do not leave room for the full complement, such reduction takes place at the hind end of the series.

Among living Carnivora the group which is in the whole the most generalised and the least widely removed from the primitive ancestral type is that of the dogs—including under this name not only the animals properly so called, but likewise wolves, jackals, foxes, etc. To enter into a consideration of the structure of the skeleton would obviously be an impossibility on this occasion, and it must accordingly suffice to mention that while the typical number of five toes are retained in the fore-foot of nearly all members of the group, in the hind foot there are only four; and that although collar-bones are developed, yet they are reduced to mere rudiments. One other important circumstance in connection with the skeleton must, however, be noticed. If the bones of the wrist, or carpus, of a dog be compared with that of man or of most other mammals except Carnivora, it will be noticed that the upper row consists of two, in place of three, elements. This is due to the fusion of two of the bones, the scaphoid and lunar; and this union is characteristic of all modern Carnivora, in which the compound bone is known as the scapho-lunar.

One other feature—and this connected with the dentition—is very characteristic of modern land Carnivora. In the skull of a cat, dog, or wolf (fig. 1) it is well known that one pair of teeth in the side of each jaw differ markedly in size and structure from all the rest, the upper biting upon the lower pair with a more or less scissor-like action. It is with this pair of specialised teeth that a tiger or a lion cuts up the masses of flesh torn from its prey into convenient lengths for swallowing; and these formidable weapons are consequently known as the carnassial, or flesh, teeth. Curiously enough, these teeth do not serially correspond with one another. It will be seen, for instance, both in figure 1 and figure 2, that while

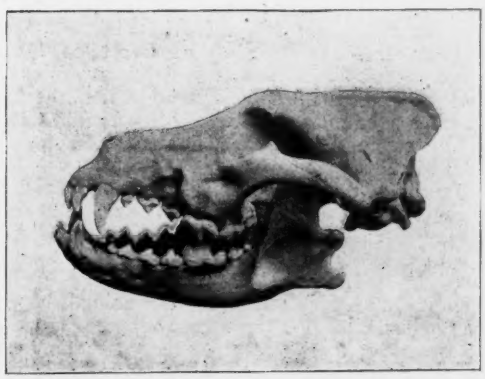


Fig. 1.—Side view of skull of Wolf to show the carnassial teeth.

the upper carnassial is the fourth from the tusk, the corresponding lower tooth is the fifth from the latter; both the species in the two illustrations referred to having the full typical series of anterior cheek-teeth. Nor is this all, for whereas the upper carnassial has no deciduous predecessor ("baby-tooth"), the corresponding lower tooth succeeds a deciduous baby-tooth. Consequently, the upper carnassial—to employ technical language—belongs to the premolar series, while the lower carnassial is one of the true molars.

Now, when we find two organs which do not serially correspond with one another, modified for some particular function, it may be at once taken for granted that this is a highly specialised condition which did not obtain in the beginning; and this we shall find to hold good in the case of the Carnivora.

From the general presence of this peculiar type of dentition, all the modern Carnivora, together with many of their extinct relatives, are collectively known as the Carnassidentia. Not that it must be assumed that this feature is common to them all. In the bears, for instance, the carnassials, although still displaying traces of the characteristic structure, have become comparatively small and weak teeth, much smaller than the grinding molars behind. And this degeneration (for by means of fossil forms the feeble carnassials of the bears can be traced

into the fully-developed ones of the dogs) may be explained by the nature of the food of bears, which does not require the action of scissor-like teeth.

Again, in the seals and walruses there is no trace of a differentiated pair of carnassial teeth; such a type of dentition being unnecessary to animals living on a fish diet. In the case of the eared seals and walruses, there is little doubt that the absence of differentiated carnassials is due to degeneration, these creatures being apparently related to the bears. The case of the true, or earless, seals is more uncertain; and it has been suggested that these creatures inherit their distinctive type of dentition direct from an extinct group referred to below. Against this is the circumstance that they possess the compound semilunar bone in the wrist, which, on the above view, would imply the fusion of the two elements entering into its composition in two independent instances.

Reverting to the existing members of the dog tribe, it will be noticed that the skull (fig. 1) is characterised by its elongated form and relatively large brain-cavity. The teeth fall short of the typical mammalian number of 44 only by a single pair—namely, the last pair of molars in the upper jaw. Consequently there are only two pairs of teeth behind the upper carnassial. In the lower jaw the last molar is very small, and evidently on the point of disappearance. As regards the other teeth, it must suffice to mention that the carnassials are strongly developed and possess a perfect shearing action, the lower one having a large tubercular portion for masticating behind the cutting blade; and that most of the premolars (other than the upper carnassial) carry accessory cusps on either side of the main cone. It may be added that all the existing members of the family are digitigrade—that is to say, they walk on their toes instead of on the sole of the foot, which is raised above the ground and covered with hair.

A large number of extinct dog-like animals have left their remains in the Tertiary strata of both Europe and North America; those from the newer formations being nearly allied to existing types, while the older forms are more or less decidedly different. One of the most important of these extinct types is the Oligocene and Miocene genus *Cynodictis*, which is without much doubt the ancestral type of the true dogs (*Canis*) of the present day. Although generally having the same dental formula as the latter, *Cynodictis* exhibits distinct signs of affinity with the ancestors of the civets. On somewhat the same platform of evolution as *Cynodictis* is the North American *Daphænus*, of which the skull is shown in fig. 2. In this animal it will be seen that a small third upper molar (the third tooth behind the carnassial) is retained, thus

Fig. 2.—Skull of *Daphænus*, a primitive Dog from the Middle Eocene strata of the United States, with a crown view of first and second lower molars. (After Dr. Wortman.)

bringing up the number of the teeth to the typical 44. In general characters, the dentition is very similar to that of modern dogs, but there are fewer accessory cusps to the premolars, and the posterior portion of the lower carnassial is adapted for cutting, instead of for grinding. The dogs of this genus are further remarkable for the shortness of their jaws; and it has accordingly been thought that they may have been the ancestors of the modern wild dogs (*Cyon*) of Asia.

Great interest attaches to another type of Tertiary dog, the *Amphicyon* of the Miocene and Oligocene strata of both hemispheres, some of the species of which attained dimensions rivalling those of a bear. This interest is due to the fact that these giant dogs, which had 44 teeth, and partially plantigrade feet, were the actual ancestors of the modern bears, with which they are connected by certain extinct genera. We thus establish the derivation of bears from dogs of a generalised type.

All the foregoing extinct general types of dogs may, however, themselves be apparently derived from a still more generalised form from the Middle, or Bridger, Eocene of North America, known as *Vulpavus*. In this animal, which can only be tentatively included in the dog family, the skull (fig. 3) is characterised by its long and narrow

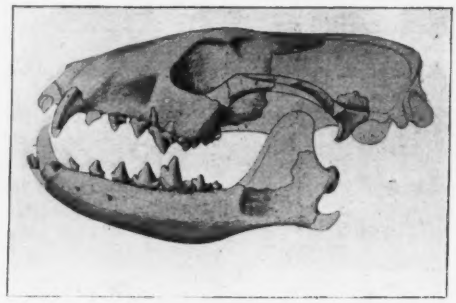


Fig. 3.—Skull of *Vulpavus*, an ancestral type of Dog from the Bridger Eocene. (After Wortman.)

form, and the small size of the brain-cavity. The teeth, of which there are 44, are of a decidedly dog-like type, but the outer front angles of the upper molars assume a cutting character, and the blade of the lower carnassial is much taller and narrower, and also more obliquely placed, than in the dogs, while the second and third lower molars, although much smaller, present a decided resemblance to the carnassial. Moreover, the lower premolars have large fore-and-aft cusps, differing in character from those of the true dogs. Unfortunately, the structure of the wrist is unknown, but it is quite possible the scaphoid and lunar bones may be separate. The hind as well as the fore feet were five-toed.

More or less nearly allied to *Vulpavus* are certain other Lower Tertiary Carnivora, exemplified by the genus *Viverravus*, which are regarded as forming the most primitive family of Carnassidents at present known. They have five-toed feet, with the scaphoid and lunar of the carpus separate; and the dentition, in which the number of the teeth may be either 44 or 40, differs from that of *Vulpavus* by minute details, to which it is impossible to refer on this occasion. In certain numbers of the family, such as *Oödectes*, the last two lower molars are exceedingly like the carnassial, and have their crowns but little lower, although these teeth retain the essential carnassident feature of being smaller than the latter. In other respects, the dentition of these primitive forms comes very close to that of the undermentioned creodonts, with which the *Viverravidæ* also

agree in their divided scaphoid and lunar. As indicated by the name of the typical genus, the *Viverravidæ* are regarded by American palæontologists as the ancestors of the civets (*Viverridæ*) of the old world; and it is not improbable that they were likewise ancestral to the primitive dogs. If it be added that there is evidence to show that the members of the weasel tribe are also sprung from a more or less nearly allied Eocene group, we shall have accounted for the origin of four of the most important families of existing land Carnivora, namely dogs, bears, civets, and weasels. As regards hyænas, there is little doubt that they are closely related to civets, with which they appear to be connected by a number of extinct forms, such as *Ictitherium*.

Leaving the raccoon family alone, it may be added that there is still some degree of uncertainty with regard to the origin of the cats (*Felidæ*). Unless, however, they trace their origin direct to the undermentioned creodonts, there seems to be considerable probability that they are derived from the imperfectly known family of primitive carnassidents termed *Palæonictidæ*, all the members of which are characterised by their short jaws and cat-like dentition. In the typical *Palæonictis*, which dates from the Wasatch, or Lower, Eocene, the carnassials are somewhat imperfectly differentiated from the other teeth; but in *Æluroterium* of the Bridger they become well characterised

Having thus traced, more or less definitely, most of the principal families of existing land Carnivora to generalised forms which are evidently on the borderland between the Carnassidentia and some more primitive type of Carnivora, we have to turn our attention to what is known with regard to the latter.

Fig. 4.—Skull of *Sinopa*, a North American Creodont. (After Wortman.)

Such primitive type is represented by the Eocene and Oligocene Carnivora collectively known as Creodontia, of which the American *Sinopa* or *Stypolophus** (fig. 4) and the European *Hyænodon* and *Pterodon* (fig. 5) are well-known representatives. In addition to other features which cannot be noted here, these creodonts are collectively characterised by three long, narrow, small-brained skulls, by the fact that the scaphoid and lunar of the wrist are usually distinct, and, above all, by the non-development of a pair of differentiated carnassial teeth. In place of these, the lower jaw (fig. 5) has all the three molars of a cutting type (m^1, m^2, m^3); and it will be further noticed that these teeth differ from the corresponding teeth of a carnassident by the circumstance that they increase in size from the first to the third, instead of decreasing. These animals all have five-toed feet, in which the thumb and the first toe may be opposable to the other digits.

Unless these creodonts have given rise to the true seals of the present day, they seem all to have died out during the Tertiary period without leaving any descendants. Moreover, they appear to have been derived from some still more primitive stock independently of the carnassidents, with the earlier forms of which latter they were, however, evidently allied. In other words, carnassidents and creodonts appear to be diverging branches from a single primitive stock, which probably lived during the Secondary, or Mesozoic, epoch.

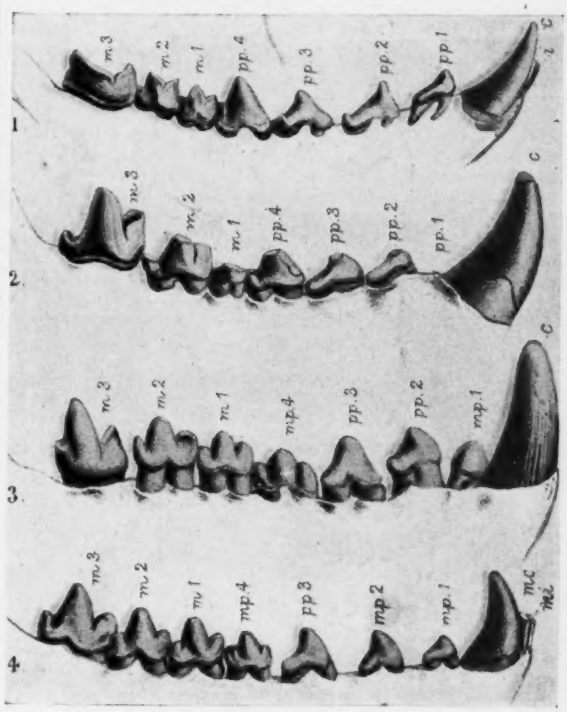


Fig. 5.—Lower Jaws of Creodonts and Marsupials. 1 *Hyænodon*, 2 *Pterodon*, 3 *Borhyæna*, 4 *Thylacinus*.

What were these Mesozoic ancestors, is the next question which presents itself.

A comparison of the lower jaws of the creodont *Hyænodon* and *Pterodon* with that of the marsupial *Thylacinus*, as displayed in fig. 5, shows at a glance that the dentition in all three is of the same generalised type; this being especially indicated by the form and relative dimensions of the three molars. It is true, indeed, that in the marsupial there appear to be four of these teeth; but this is due to the fact that the tooth in advance of these (m.p. 4) is a persistent milk-tooth, which is not replaced, as in the creodonts, by a permanent premolar (pp. 4). Certain South American extinct types such as *Borhyæna* (fig. 5—3) are intermediate in regard to the number of teeth replaced between creodonts and marsupials, in the latter of which only one (pp. 3) is so changed, and it is consequently a difficult question to say whether these South American forms should be classed as creodonts or marsupials.

Be this as it may, it is quite evident that creodonts and marsupials are nearly related, and have probably both sprung from Mesozoic ancestors. The next question is whether these Mesozoic ancestors should be called creodonts or (in a wide sense) marsupials. Unfortunately the degree of preservation of the comparatively few and imperfect known remains is such as to preclude a definite answer being given to the question. Dr. Wortman, to whose opinion I attach great value, inclines to the belief that they were marsupials. Personally, basing my opinion on the restricted tooth-

* Represented in Europe by the closely allied *Cynohyænodon*.

change of the latter, I am more disposed to call the Mesozoic forms primitive creodonts, and to consider creodonts as the ancestors of marsupials, rather than *vice versa*.

The whole question is, however, absolutely bristling with difficulties and uncertainties, and involves the discussion of a number of technicalities which cannot possibly be touched upon here.

With this, then, I must leave the subject, merely adding that after having traced the specialised modern Carnivora into early types closely allied to the primitive Creodontia, and having also pointed out the existence of a near affinity between the latter and the carnivorous marsupialia, the question naturally arises whether the middle Mesozoic mammalian forerunners of these groups may not themselves be the descendants of the carnivorous mammal-like reptiles (theriodonts) of the early part of the same epoch, which have a typical carnivorous type of dentition. If so, the dog and civets of our own day have a truly ancient pedigree.

Is there Snow on the Moon?

A Study of the Lunar Apennines.

BY E. WALTER MAUNDER, F.R.A.S.

THE principal object in the accompanying Plate, which is reproduced from one of the superb photographs taken by MM. Loewy and Puiseux, with the great equatorial coudé of the Paris Observatory, is the range of the lunar Apennines, by far the grandest mountain chain upon the moon, and the one which, at first sight at least, most strongly resembles those of our own earth. It is shown in its entire length of more than 400 miles from the fine ring-plain Eratosthenes, in the extreme right-hand upper corner of the Plate, which forms the termination of the range to the south, down to the grand promontory of Mount Hadley, more than 15,000 feet in height, in which it ends towards the north. About halfway between the two extremities of the range is the magnificent headland of Mount Huyghens, according to Schröter nearly 21,000 feet in height, the highest summit on the moon with the exception of some of the peaks on the ramparts of the ring-plains of the south polar cap. A third great promontory, Mount Bradley, lies nearly midway between Mount Huyghens and Mount Hadley and reaches a height of about 16,000 ft.

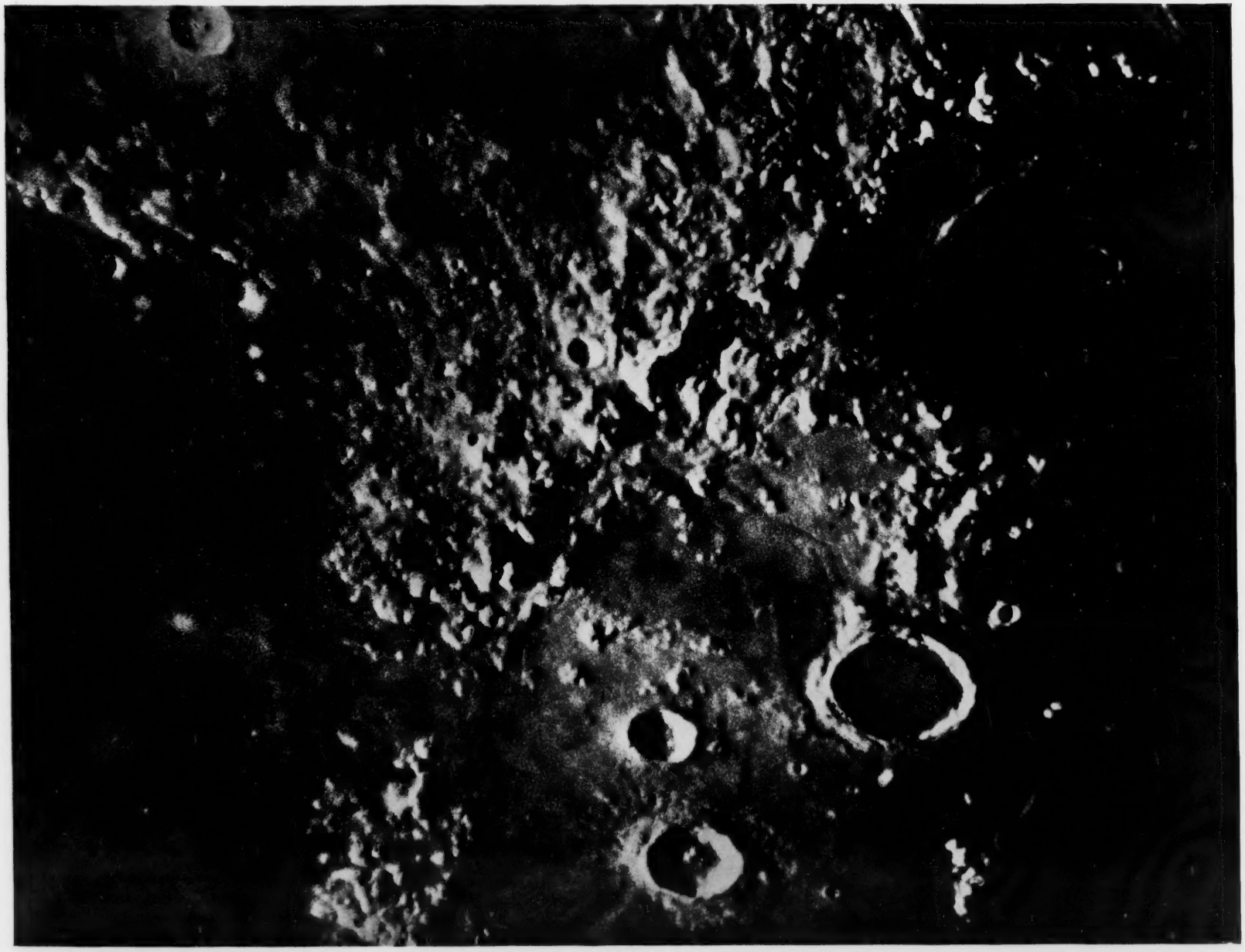
The highland region, of which the Apennines form the north-eastern face, is roughly triangular in shape. By far the loftiest and steepest face is that overlooking the great Mare Imbrium towards the east. The north-western face looks over the Mare Serenitatis, whilst the Sinus Æstuum and the Mare Vaporum bound the region on the south.

The area of the Plate is not one which includesm any of the circular formations so typical of the moon, but some of those which are shown are very striking. Three great ring-plains are seen on the floor of the Mare Imbrium. These, in order of size, are Archimedes, the largest and most eastern, Aristilles, the most northern, and Autolycus, the smallest of the three, just opposite the broad gap which separates the Apennines from the Caucasus. On the opposite side of this opening, and slightly further from it, the celebrated crater Linné is seen as a small white spot on the floor of the Mare Serenitatis. Toward the extreme upper left-hand corner of the Plate, near the border of the same Mare, stands the bright crater Sulpicius Gallus, and amongst the actual highlands of the Apennines are the two craters Conon, just behind Mount Bradley, and Aratus, a little further north towards Mount Hadley. These seven are the most notable circular formations in the Plate. In general, the lunar mountains take the form of rings or polygons, as in the case of these seven objects, and do not make continuous chains as on the earth. To this rule the Apennines constitute the most conspicuous exception, but a detailed examination of them shows that the differences between them and the great terrestrial ranges are numerous and significant.

The first feature of the Apennine highlands to claim attention is the nearly triangular form of the area they cover. This is a necessary consequence of the roughly circular form of the great Maria which border them. Wherever we have a number of circular depressions contiguous to each other, the more elevated interstices must necessarily approximate to triangles. And this being the case, it follows that the forms of the highlands have been determined by the Maria and not the reverse. In other words, the highlands existed first and acquired their present outlines through the later formation of the surrounding Maria.

SOUTH.

WEST.



EAST.

NORTH.

The Lunar Apennines.

From a Photograph taken 1895, March 4, 6h.6, Paris Mean Time, with the Equatorial Coudé of the Paris Observatory.

Scale: Diameter of Moon, 44 inches; Moon's age, 9d. 1h.7

The next feature to be noticed is the general slope of the region. Towards the Mare Imbrium on the east, the face presented by the Apennines is exceedingly bold and steep; towards the Mare Serenitatis and Mare Vaporum on the west and south the highlands sink down gradually.

Fig. 1.—Morning.

The result of such a formation upon the earth would be obvious. There would be a deposition of moisture over the whole highland region, either in the form of snow or water, and this moisture would move downwards towards the plains either as streams or glaciers. But it would move with very different speed and different effects upon the two faces. On the steep escarpment facing east

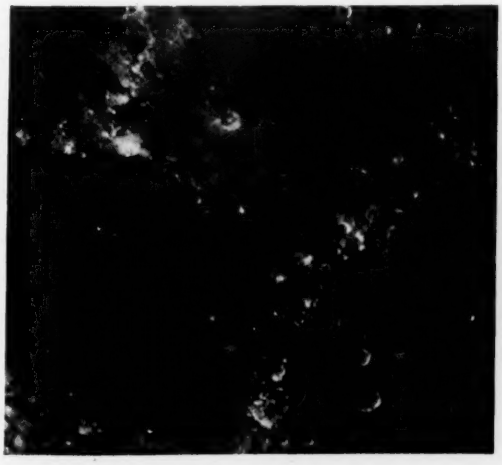


Fig. 2.—Forenoon.

neither water, snow, nor ice could rest. The moisture would be quickly thrown off, descending in waterfalls or avalanches down to the plains, and wearing away the cliff face into a great number of narrow gorges or gullies. The *débris* would be deposited at the foot of the cliffs, and the torrents would carve their way some distance into the plain, as a rule in a direction at right angles to the range, smoothing out and covering all irregularities which ran parallel thereto. What we actually see upon the photograph is as unlike this as could well be imagined. The base of the range in the Mare Imbrium is confronted by a line of low hills, wrinkles as it were on the surface of the plain, suggesting by their parallelism to the range

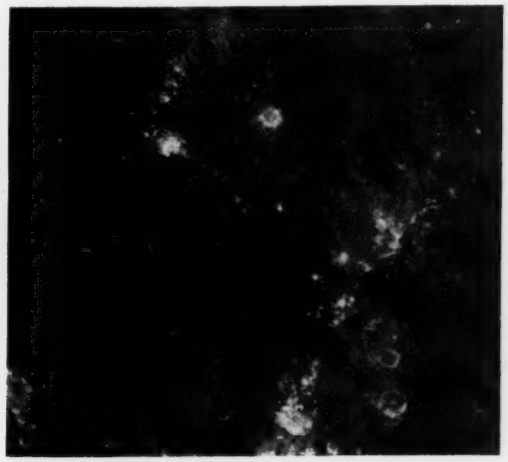


Fig. 3.—Noon.

that no effective amount of moisture, either as rain or snow, had been deposited on the eastern slopes of the Apennines since the Mare Imbrium was formed.

But the main drainage of the region would be in the opposite direction, because the chief catchment area would be the broad gentle slope towards the west and south. Here the tendency would be for the moisture, whether it

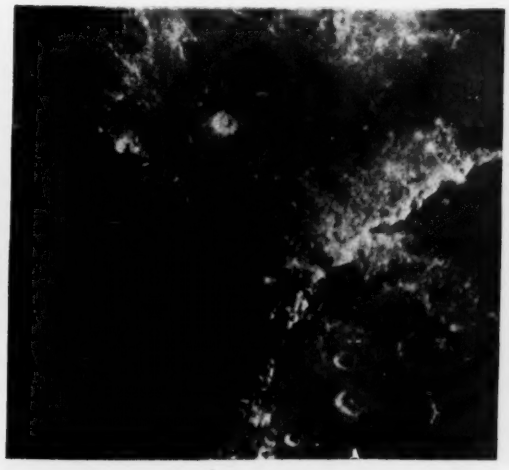


Fig. 4.—Afternoon.

was in the form of ice or water, to unite small streams together to form larger ones. Important rivers or glaciers would have their origin in this region, and would work their way downwards excavating broad valleys. The erosive effects, if not so rapid as on the east face, would, from the better presentment to us, be even more conspicuous, and there should be no difficulty in detecting

the deposit of alluvium at the mouths of the great water-courses. We do indeed find valleys and ravines on the western slopes, but these often are so blocked or show so many irregularities of level that they cannot be held to be water channels. If this was their original nature, then the more recent history of the moon must have entirely changed their appearance; we see nothing to remind us of the characteristic arrangement of a drainage area on the earth. More than that, we find in the neighbourhood of Sulpicius Gallus a dark band parallel to the edge of the Mare Serenitatis, as if the Mare was actually deeper here than further out in the plain. Such a channel would have inevitably been filled up by the alluvium washed down by rivers draining the highland district.

It is very instructive to watch the apparent changes produced in any region of the moon by the progress of the lunar day. The five photographs of the regions of the Apennines shown in figs. 1-5 are reproduced from Professor W. H. Pickering's "Photographic Atlas of the Moon," noticed in the last number of "KNOWLEDGE," and will give some idea of the great value of this systematic mode of study which Professor Pickering has

Fig. 5.—Evening.

carried out. It will be seen at once that the change in the lighting produces an immense change in the general appearance of the region. The five photographs we may describe for purposes of reference as showing the district at morning, forenoon, noon, afternoon, and evening; descriptions which are only roughly correct, but which will suffice for reference. It will be seen at once that the appearance of relief vanishes almost entirely at noonday; it increases directly in proportion to the obliqueness of the illumination, and is very marked in the last photograph of the series taken almost at sunset. The two great craters, Archimedes and Eratosthenes, are practically lost at noon. At this time the brightest objects are the glittering peaks of the Apennine range, the rampart of Conon, and the white mantle surrounding Aratus. In early morning and late evening the gradual slopes of the highlands towards the west, and their steep declivities towards the east, are the regions which respectively shine out most conspicuously. But it is the latter which are by far the most brilliant; and, looking at the fifth photograph, there would seem not a little to justify Professor W. H. Pickering's description of them as snow covered. "Many of the higher summits of the Apennines," he writes, "are brilliant with snow, although the sun is just setting upon them, whilst the slopes of the intermediate valleys and of the foothills are dark."

Professor Pickering's interpretation of the brilliancy of the eastern* slopes of the Apennines involves several assumptions. He considers that the deposition of snow will vary on the moon according to the elevation of a district and according to its distance from the equator. But it should be borne in mind that elevation on the moon will not be nearly as effective in producing condensation as on the earth. The action of gravity at the lunar surface is but one-sixth of what it is with us. This would have a two-fold effect. Whilst here we reach a region of half the surface pressure at a distance of three and a half miles, on the moon we should have to ascend more than twenty-one miles to obtain the same proportional diminution, whilst the feebleness of gravity would make any upward motion of the atmosphere exceedingly slow. The cooling of an ascending current of air by expansion, here the most efficient cause of condensation, would there be practically inoperative, and the great tenuity of the lunar atmosphere would tend in the same direction. There would scarcely be any perceptible difference in the readiness with which condensation would take place between the plains and the mountain summits.

The comparison of the five pictures, too, does not support the inference that the bright regions are snow-covered. The western gentle slopes are by no means so bright under their best illumination as the steep eastern escarpments are under theirs. Yet it is on the former that we should expect the snow to lie, whilst as they are best lighted by the morning sun, that is to say, just as they emerge from the long lunar night when the snow should be thickest, we should expect them to be far more fully covered, and therefore more brilliant than the steep eastern slopes could be at sunset, after having undergone the continued action of the sun during the whole length of the lunar day. The changes in illumination are indeed just what we might expect from the varying incidence of the solar rays, provided that there was some difference in the reflective power of the different surfaces. And in this case there is no difficulty in pointing out a sufficient cause for the steep slopes being more brilliant than the gentle. Mr. Davison ("KNOWLEDGE," December, 1896, p. 278) pointed out that objects on a slope from, the mere effect of the expansion during the heat of the day and contraction under the cold of night, would steadily creep downwards. There would thus be a very slow but continuous transference of free solid particles from the summits of the mountains towards the plains, uncovering fresh surfaces in the higher regions, and this creeping effect would necessarily be much more rapid on such steep declivities as the eastern face of the Apennines than on the gradual slopes towards the west. If then the very tenuous atmosphere which we may readily believe to exist upon the moon be capable of effecting some slight tarnishing or darkening effect in the course of centuries, or if the deposition of meteoric dust, which must be much the same as upon our earth, slowly coats our satellite with a thin dark veil, we shall find a sufficient explanation for the difference in albedo of the mountain peaks and of the great plains.

This explanation is emphasised by the consideration of a point which Professor Pickering brings forward in proof of the existence of snow deposit. He points out

* I use the terms "east" and "west" throughout this paper, from our point of view. An inhabitant of the moon would, of course, regard the slopes facing the sunset as the western slopes.

that though the central regions of the disc are as "rough and mountainous as that near the pole" they are very much darker. It is hardly the fact that the equatorial regions are as rugged as those of the North Pole, but when we compare the equatorial regions with the polar under the same conditions of foreshortening as well as of illumination the latter have no evident superiority in brightness. It is abundantly clear why the regions near the edge of the disc, whether polar or equatorial, appear the brightest, for it is just here that the darker valleys are concealed from us and that the steep mountain slopes are presented to the fullest advantage.

The question as to whether there are anywhere upon the moon deposits of snow is too large a one to be settled by an appeal to the evidence which even so grand and extensive a formation as the Apennines and their highlands can afford, but so far as they are concerned the verdict would clearly seem to be in the negative. It must always be difficult to distinguish upon the moon between changes which are simply due to changed illumination, and therefore which are apparent only, and changes which are real but are strictly seasonal, for the period of both will be the same. But in this particular region both theory and observation seem to unite in discountenancing the idea of snowfall and in ascribing the apparent changes in the brightness of the Apennine highlands purely to the varying incidence of light on surfaces of different reflective power.

The Canals of Mars.

By W. F. Denning, F.R.A.S.

Recent observations and discussions in reference to the canals of Mars have been very important and will be the means of clearing up doubtful points and putting our knowledge of the planet's surface configuration on a well-assured basis. The fact that many of the spots on Mars represent real features give them a special interest, for the other large planets of our system appear to be too densely involved in atmospheres to exhibit the material conformation of their globes.

Schiaparelli discovered the canaliform aspect of Mars in 1877, and the general correctness of the Italian astronomer's work has been affirmed by many of the leading planetary observers in subsequent years. But the path of the pioneer is difficult and apt to carry one a little astray through its general direction may be accurate enough. Schiaparelli has not been successfully followed in all the details included in his charts of Martian topography, nor has the doubling of many of the canals been corroborated. But apart from the latter peculiarity his delineations form the best working basis for present observers, and carry us far beyond the charts of Green, whose well-executed drawings are marred by the fact that he was over-scrupulous as to the insertion of details not prominently distinguishable.

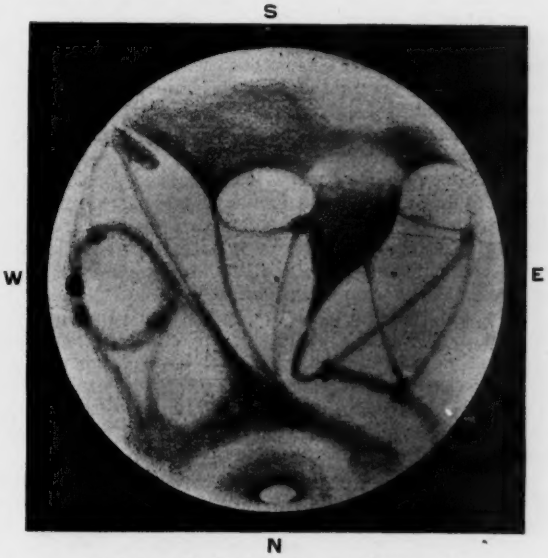
Schiaparelli has no doubt delineated the canals under aspects too straight, hard, and uniform. For the most part the telescope displays them as really faint pencil-like streaks or veins, knotted with darker regions and by no means of equable width or even tone. Though classed under one name and drawn in a uniform way they certainly represent very dissimilar objects.

Some of the canals are due to contrast, and really apply to the boundaries between dusky areas toned a little more deeply than the outlying parts of the ruddy surface.

Others are pretty consistent with their title, being formed of streaks apparently connecting well-known spots, and sometimes meandering over extensive tracks of the surface.

Others again are composed of small irregular condensations, lying approximately in rows and roughly blended together under the aspect of bands in which much detail may be momentarily glimpsed. With ordinary telescopic power, however, their general appearance on the small disc is that of streaks or canals, and the observer figures them as such, being unable to satisfactorily define their structure in detail.

In March, 1903, I began a series of careful observations of Mars with a 10-inch reflector. Favourable weather during the ensuing two months enabled me to examine the planet on 26 nights, when 36 drawings were made. On the first few nights I detected some of the canals under absolutely certain characters. A considerable number of those shown in Schiaparelli's charts were identified, and the result of my scrutiny was to prove the general correctness of his drawings. But I utterly failed to recognize the supposed double canals. To my eye, the lines were invariably single under the highest powers I could effectively apply, and I am bound to conclude that the gemination is not a real feature.



Mars in the Spring of 1903. Longitude, 265°. 10-inch Reflector. Powers, 312 and 375.

During my observations several striking changes were remarked in prominent objects, and these were probably occasioned by atmospheric movements on the surface of the planet. The presence of clouds or obscuring vapours must, however, have affected relatively small regions, for the markings were usually visible from night to night under similar aspects, allowance being made for the variable definition.

The white spots formed striking features, and especially so when on or near the edge of the disc. They appeared to be equally as permanent as the dark markings.

From observed transits of the Syrtis Major, compared with some I obtained with a 4¼-in. refractor in February, 1869, I determined the rotation period as 24h. 37m. 22·7s. from 12,136 rotations.

There are really many distinctions in the canal-like markings; some of them are quite broad and diffused hadings, while others are narrow, delicate lines. The

dusky knots (called Oases by Lowell, who claims to have discovered them) were distinctly seen here in 1884, 1886, and other years. In *Nature* for June 3, 1886, I refer to the canals as "linear shadings with evident gradations in tone and irregularities occasioning breaks and condensations here and there."

The ingenious experiments conducted by Messrs. Maunder and Evans (*Monthly Notices*, June, 1903) explain some of the observational results without throwing doubt on the whole canal-system of Mars, as some readers have supposed. Certain of the canals are indeed so conspicuous as to form objective features comparable in point of distinctness and certainty with the dark belts of Jupiter and Saturn.

If we could greatly enhance telescopic power and examine Mars under a sufficiently amplified disc, the canals would probably look very different to those shown in the miniature views supplied in ordinary instruments. We should see them as large blotchy bands of dusky material having no resemblance whatever to sharply-cut waterways. The south equatorial belt of Jupiter consists of a series of spots, and it presents a curious transformation under magnifying powers of 50 and 500. With the former it forms a very dark narrow streak, but with the latter it is broken up into masses of flocculent material covering an extensive track.

If the existence of the Martian canals has been doubted, it is partly the fault of certain observers who have greatly multiplied the real number of these objects, drawn them under unnatural aspects, and elaborated the general appearance of Mars in a manner palpably inconsistent with telescopic revelations.

Mr. Story remarks that "it is time an end should be put to the inquisitorial fashion of refusing credence to scientific discoveries." It is true that certain forms of criticism merely harass and embarrass observers, without effecting any useful purpose. On the other hand, we cannot unreservedly accept everything offered us in the way of observation, real and visionary, objective and subjective. Astronomical history would form a curious medley of fact and fiction (chiefly the latter) if all the supposed "discoveries" of past years were credited and reiterated. Criticism has occasionally proved a wholesome and necessary corrective to results of abnormal and unsupported character.

Conflicting testimony in planetary observation is usually attributed to the differences in telescopes, eyesight, and local atmospheric conditions. But the more potent cause is to be traced to the observers themselves, who differ widely in their discretion, judgment, and interpretations. One man will accept and possibly elaborate extremely delicate features very imperfectly and uncertainly glimpsed. Another will absolutely reject similar appearances. Two things come actively into play and are directly opposed, viz.: (1) The dominating desire to glimpse novelties and gain repute by eclipsing past records; and (2) the necessity of accepting only what is certainly and steadily seen to the exclusion of all doubtful features. On these points observers differ vastly; some of them do not sufficiently realise their responsible positions, and hurriedly make records not justified by telescopic evidence; others are perhaps too punctilious and apt to reject details which are real, though only faintly and fitfully glimpsed.

In judging the quality of results it should be remembered, as a most important factor, that the individual characteristics of the observer play a very prominent part. Some people possess the faculty of seeing objects double. Others will invariably discern novelties where none are visible. Others, again, will detect canals as a necessary feature of a planetary disc. Thus Mercury and Venus have been supposed to display these markings very conspicuously. Phenomenal vision will not explain the anomalies alluded to. Objective markings are capable of being corroborated without any difficulty. The spots on Saturn were distinguished by many observers shortly after their discovery. There is no reason why canals should prominently diversify Mercury and Venus as seen by one observer, while as viewed by others the discs of those planets appear, under the best circumstances, absolutely free from such markings. On many occasions during the last few years the beautifully defined disc of Venus has been examined by the writer, but not the vestige of a canal has ever revealed itself; yet at the Lowell Observatory, Mexico, "the markings are perfectly distinct and unmistakable, invariably visible, and nothing but a very unsteady air can obliterate them" (*Monthly Notices*, Vol. LVII. 1896-7, pp. 149 and 402).

Flammarion was probably quite correct in his expression ("KNOWLEDGE," November, 1897) that "the maps of Venus made up to the present time are illusions."

But our present concern is with Mars. The story of his canal-like markings is a true one, though it has been occasionally exaggerated, and it will survive all the opposition levelled against it by sceptics and incapable observers. The northern hemisphere of the planet seems replete with dusky streaks forming the canals. They may not indicate water courses, and their real aspect may be something very dissimilar to that displayed in ordinary telescopes, but with the means employed observers are correct in representing many of them as lines and bands of shading connecting the more bulky spots.

The Spinthariscope.

THE ingenious instrument to which Sir William Crookes gave the name of the Spinthariscope, and which he devised to show the torrent of rays or the fragments of atoms which are continually being shot out from radium, is now a familiar object to most scientific people. The instrument as is well known consists of a little screen of zinc sulphide or blende, at a slight distance from which a fragment of radium bromide is situated on a pointer. As the emanations from the radium strike the screen they produce an effect similar to that which a bullet produces when it strikes a target, and by means of a magnifying glass the phenomenon is rendered clearly visible. The instrument is now made by Messrs. A. C. Cossor, and one of them which has been sent to us shows the scintillation with remarkable clearness and vividness. It is, perhaps, the most ingenious, and certainly the most lasting, scientific toy that ever has been produced.

SOME time ago, in a lecture to the Camera Club, Mr. Duncan destroyed the poetic belief, relating to the nautilus, which is expressed in Pope's lines:

"Learn of the little nautilus to sail,
Spread thine oar and catch the driving gale"—

by remarking that the little sails which the nautilus was popularly and poetically supposed to spread were, in fact, never raised at all, but were always tightly clasped about the shell. In a paper contributed to the *Natural History Magazine*, Captain Barrett Hamilton disturbs an idea relating to the wings of the flying fish that is at least equally widespread. In the true flying fish Captain Hamilton says the "wings" are never moved as organs of flight. They may vibrate or quiver under the action of air currents, or a shifting a little of their inclination by the fish, but the whole motive power is supplied by the powerful tail. The wings are a parachute to augment the action of this propeller. Their motions are in no way comparable to those of the wings of a bird.

The Face of the Sky for April.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 5.38, and sets at 6.31; on the 30th he rises at 4.37, and sets at 7.19.

The equation of time is negligible on the 15th and 16th, hence these are convenient days for the adjustment of sun dials or for laying down a meridian line to a close approximation.

Sunspots are of frequent occurrence; their positions may be located by the use of the following table:—

Date.	Axis inclined to W. from N. point.	Centre of disc, S of Sun's equator.
April 5 ..	26° 29′	6° 12′
,, 15 ..	26° 14′	5° 27′
,, 25 ..	25° 14′	4° 34′

THE MOON:—

Date.	Phases.	H. M.
April 7 ..	☾ Last Quarter	5 53 p.m.
,, 15 ..	● New Moon	9 53 p.m.
,, 23 ..	☽ First Quarter	4 55 a.m.
,, 29 ..	○ Full Moon	10 36 p.m.
April 10 ..	Apogee	9 30 p.m.
,, 26 ..	Perigee	6 36 p.m.

Occultations.

The following are the principal occultations visible at Greenwich at convenient times:—

Date	Star's Name.	Magnitude.	Disappearance.		Reappearance.		Moon's Age.
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.	
							d. h.
April 2	49 Librae	5·6	11.4 p.m.	94°	12.9 a.m.	297°	17 17
,, 4	B.A.C. 3398 ..	5·9	9.25 p.m.	118°	10.33 p.m.	284°	9 0
,, 28	*m* Virginis	5·3	10.6 p.m.	103°	11.18 p.m.	303°	13 0
,, 29	B.A.C. 4828 ..	6·0	9.40 p.m.	75°	10.37 p.m.	327°	14 0

THE PLANETS.—Mercury should be looked for in the N.W. shortly after Sunset from the 15th to the end of the month. About this time the planet is in the most favourable position for observation for the present year, and sets about two hours after the sun. On the 21st he arrives at greatest easterly elongation of 20° 11′, and although this is not so large as the autumnal elongation, the greater inclination of the ecliptic to the horizon at this time puts the planet into a much more favourable position for observation.

The diameter of the disc is 8″·0.

Venus cannot readily be observed, as she only rises about half an hour in advance of the Sun, and is thus lost in the bright dawn.

Mars is practically unobservable, as he sets before it is really dark.

Jupiter was in conjunction with the Sun towards the end of last month, and is therefore too close to the Sun for observation.

Saturn is a morning star, rising at 3.15 a.m. near the middle of the month; he is situated in Capricornus, and consequently low down in the sky.

Uranus rises on the 1st about 1.30 a.m., and on the 30th at 11.30 p.m.; throughout the month the planet is close to 4 Sagittarii, being only six minutes west and having approximately the same declination as the star.

Neptune is getting more to the west, and sets about 8.30 p.m. near the middle of the month. He is describing a retrograde path towards η Geminorum; his position with respect to that star may be seen on reference to the chart given in the January number.

METEOR SHOWERS:—

Date.	Radiant.			Characteristics.
	R.A.	Dec.	Name.	
	h. m.			
Apr. 17-May 1	16 0	+ 47°	τ Herculids	Small; short.
,, 20-21	17 20	+ 36°	π Herculids	Swift; bl. white.
,, 20-22	18 4	+ 33°	**Lyrid Shower**	Swift.
,, 30	19 24	+ 59°	*o* Draconids	Rather slow.

THE STARS.—About the middle of the month at 9 p.m. the positions of the principal constellations are as follows:

ZENITH . Ursa Major.

NORTH . *Polaris;* to the right, Ursa Minor and Draco; to the left, Cassiopeiæ and Perseus; below, Cepheus and Cygnus.

SOUTH . Leo and Hydra; to the south-east, Virgo; to the south-west, Gemini (high up), *Procyon*, and *Sirius* (setting).

WEST . Taurus, Pleiades, and Orion, all rather low down.

EAST . *Arcturus*, Corona, and Hercules; to the north-east, *Vega* rising.

Minima of Algol may be observed on the 7th at 10.38 p.m., 10th at 7.27 p.m., and 30th at 9.10 p.m.

TELESCOPIC OBJECTS:—

Double Stars:—γ Virginis, XII.^{h} 37^m, S. 0° 54′, mags. 3, 3; separation 5″·7. Binary system; both components are yellow, though one is of a deeper hue than the other. An eyepiece of a power of 30 or 40 is required on a 3-in. to effect separation.

π Boötis, XIV.^{h} 36^m, N. 16° 53′, mags. 4, 6; separation 6″. Requires a power of about 40.

ε Boötis, XIV.^{h} 41^m, N. 27° 30′, mags. 3, 6½; separation 2″·7. Very pretty double, with good colour contrast, the brighter component being yellow, the other blue green.

ξ Boötis, XIV.^{h} 47^m, N. 19° 31′, mags. 5, 7; separation, 2″·4. Binary; one component being orange, the other purple.

Clusters:—M 3 (*Canes Venatici*). XIII.^{h} 38^m, N. 28°48′. This object, though really a globular cluster of myriads of small stars, appears more like a nebula in small telescopes. It is situated between Cor Caroli and Arcturus, but rather nearer the latter.

XUM

NOTES.

ASTRONOMICAL.

M. Janssen's Photographic Atlas of the Sun.

SOME twenty-eight years ago, M. Janssen set on foot a photographic study of the solar surface at the Meudon Observatory, of a somewhat special kind. His object was to obtain the greatest possible sharpness of definition, and for this purpose he had an objective constructed for him by Prazmowski which brought the rays near the G line of the Fraunhofer spectrum, and practically these alone, to a well-defined focus. In conjunction with this instrument he used collodion plates, sensitised by bromo-iodide, in which the iodide predominated, with a small range of sensitiveness which corresponded to the region of the spectrum for which the object glass had been constructed. The photographs were therefore obtained almost by monochromatic light, and were exceedingly sharp. The objective employed had an aperture of 0·135 metres and focal length of 2 metres, a secondary magnifier enlarging the image of the sun in the telescope some 15 diameters. Some of the most characteristic and best defined from the store of over 6000 negatives which have now been accumulated at the Meudon Observatory have been reproduced, enlarged four times from the originals, in a superb atlas, recently published by M. Janssen. These plates, 30 in number, and 21 inches by 18 in size, are on a scale of about 4 feet to the solar diameter, and show the intimate structure of the solar surface with a minuteness and detail never seen in any previous publication; the minute granulation of the surface and the different forms of the réseau photosphérique being most admirably illustrated.

* * *

Some Peculiarities of Comets' Tails.

In an article in "Popular Astronomy," illustrated by a number of beautiful photographs, Professor Barnard draws attention to some peculiarities apparent in the photographs of some recent comets which do not seem to be sufficiently explained by the well-known theory of Professor Brédikhine of the repulsive action exercised by the sun upon the cometary nucleus. The comets specially remarked upon are those of Swift, 1902; Brooks, 1893; and Borrelly, 1903. The remarkable way in which the tail of Brooks' Comet was contorted and broken on October 22, 1893, seems to clearly indicate that it had encountered some resisting or disturbing medium. The case of Borrelly's Comet was not less remarkable, but of a different kind. Here a tail, itself apparently uninjured, was seen at a distance from the head. In this case there seems to have been a slight but sudden change in the direction of the emission of matter from the comet's head, thus cutting off the supply from the first formed tail. The detached tail, however, showed no clear evidence of acceleration in its motion, and this would suggest that the sun had little to do with its flight into space.

* * *

Radial Velocities of Twenty Stars of the Orion Type.

Amongst the Decennial Publications of the University of Chicago is a Memoir by Messrs. Edwin B. Frost and Walter S. Adams upon the motions in the line of sight of twenty stars of the Orion type. The photographs of these spectra were obtained with the Bruce spectrograph attached to the great refractor of the Yerkes Observatory. The comparison spectrum was always that of titanium, and sometimes, in addition, iron or chromium, or else a helium tube which also gave the hydrogen lines. The absolute velocities of the twenty stars observed was evidently very small, and when corrected for the solar motion gave 7 kilometres a second as the mean of the twenty radial velocities. The proper motions of these twenty stars (not their *real* radial velocities, as Professor Frost's memoir has been curiously misread) are exceedingly small; the mean for nineteen of them only being 0″·015 on a great circle, which is much smaller than for solar stars of corresponding brightness, and indicates that the Orion type stars are, as a class, very remote. A classification of thirty-one stars of the type is given at the end of the paper, according to the character of the lines of helium, silicon, nitrogen, and oxygen in their spectra.

* * *

The Stars of Secchi's Fourth Type.

Another of the Decennial Publications is a Memoir by Professor Hale and Messrs. Ellerman and Parkhurst on the spectra of stars of the type of 152 Schjellerup, the Fourth Type of Secchi's classification. The spectra of eight stars were examined, and some most important conclusions reached. A great number of bright and dark lines were detected over and above the violet flutings of cyanogen, and the flutings of the Swan spectrum. Of the dark lines, a large number were measured, showing the presence of carbon, hydrogen, magnesium, sodium, iron, calcium, and other metals recognised in the sun. The carbon and metallic vapours appear to be very dense, and to lie immediately above the photosphere; above these dense vapours are others giving rise to the bright lines, of which about 200 are present. None of these could be identified with certainty, but a few may possibly correspond to the bright lines of the Wolf-Rayet stars, which the Fourth Type spectra resemble in some other characteristics. Many lines widened in sunspots are represented by strong dark lines, suggesting that these stars may be largely covered by spots akin to those of our sun. Some twenty per cent. of the Type appear to be variable, exceeding the proportion observed in the case of Third Type stars. Professor Hale suggests that the Third and Fourth Types should be classed together as probably having developed from stars like the sun through loss of heat by radiation.

ZOOLOGICAL.

The Colours of Lobsters and Prawns.

EXPERIMENTS undertaken many years ago were believed to demonstrate that the colouring of crustacea was largely, if not entirely, of a protective nature. For instance, when prawns or young lobsters were placed, in broad daylight, on black dishes, the pigment-bearing bodies, or "chromatophores," in their integument were observed to expand, with the result that a dark type of coloration in harmony with the tone of the surroundings was produced. Conversely, when the creatures were placed on a white dish, the pigment bodies contracted, with the resulting production of a pale tone of coloration, harmonising so far as possible with the background. Moreover, if the crustaceans were deprived of sight, no such adjustment of colouring occurred, although it took place immediately that vision was restored.

From these and other experiments, it has become the current opinion that the pigments of crustaceans are superficial and sporadic in distribution, that they are confined to single cells — chromatophores — of the epidermal or connective tissues, and that they are either protective in function or form a waste functionless product of development.

Recently, the subject has been taken up anew by Messrs. Keeble and Gamble, the results of whose investigations appear in the *Philosophical Transactions* of the Royal Society. While fully recognising the paramount influence of background on the colours of crustaceans, the authors find themselves compelled to adopt an attitude of reserve and indecision in regard to most of the foregoing points. They state, for instance, that even the protective function of colour is not definitely determined by experiment; while pigment in crustaceans may be deep-seated, and may also occur in complex organs not functionally related to one another. Further investigation is necessary before anything definite can be predicated as to colour-function in these creatures.

An English Spiral-Sawed Shark.

For many years certain remarkable bodies, somewhat resembling a large watch-spring armed on the convex side with teeth, have been known from the Carboniferous and Permian rocks of various countries; the most nearly complete coming from Russia. There has, however, been much uncertainty as to their true nature. At first they were supposed to be the fin-spines of fishes; but the aforesaid Russian specimens clearly showed that they belong to the front of the jaws of sharks, and that they are true teeth, which are mounted upon their supporting base in such a manner as to form a spiral. Hence the name of spiral-sawed sharks for the group to which they pertained. Hitherto this group has been known only from North America, Australia, Japan, and Russia; the type genus being *Edestus*. Recently, however, Mr. E. T. Newton, in the *Quarterly Journal of the Geological Society*, has described part of the "saw" of one of these remarkable sharks from a marine band in the Coal Measures of Nettlebank, North Staffordshire, giving the name of *Edestus triserratus* to the species it represents.

* * *

The Medusa of Lake Tanganyika.

The discovery of the Freshwater Medusa, *Limnoclida Tanganyikæ*, in Lake Victoria, which was announced to the Zoological Society of London at their meeting in December last by Professor Ray Lankester, is an event of some scientific importance, as this remarkable form had been previously believed to be entirely restricted to Lake Tanganyika, and to be one of the most significant pieces of evidence in favour of Mr. Moore's theory of Lake Tanganyika having been formerly connected with the ocean. When Professor Lankester exhibited his specimens he was not quite certain that they had been obtained in Lake Victoria, but we believe that further information recently received leaves absolutely no doubt on this point, the specimens having been taken in Kavirondo Bay by Mr. Hobley. Moreover, confirmation on this subject has been furnished by a French Naturalist, M. Ch. Gravier who obtained nine examples of this Medusa in the Bay of Kavirondo on the 16th of September last year, as has been announced by M. Perrier to the French Academy of Sciences. M. Perrier agrees with Professor Lankester in considering the Medusa from Lake Victoria to be identical with that of Lake Tanganyika, and of this we believe there is no doubt.

Some people have thought that this remarkable discovery is rather a serious blow to the theory of the "halolimnic" nature of Lake Tanganyika, but Mr. Moore does not seem to be at all disconcerted by it. In a letter to *Nature* (of February 18th) he maintains that so far from this fresh piece of knowledge "being in any way antagonistic to the view in question," the existence of the Medusa in other Lakes is "exactly what one would anticipate, supposing the halolimnic theory to be correct." Mr. Moore thinks that it may be explained in two ways. It is quite possible, he believes, that the Medusa may be a recent importation into Lake Victoria from Lake Tanganyika, caused by the opening of new trade-routes between the Lakes, and the carriage of water in gourds and other vessels from one lake to another. If this shall be found not to have been the case, then future researches will probably result in the discovery of the rest of the "halolimnic fauna," or part of it, in Lake Victoria. This, it is maintained by Mr. Moore, would confirm the view that he has already put forward, "that the ancient sea from which the halolimnic relics sprang spread much further towards the east than was at first supposed."

To settle this and many other interesting problems it is certainly advisable that a much more accurate investigation of the Fauna and Flora of Lake Victoria should be made than has yet taken place. Lake Tanganyika seems to have more attention paid to it as yet than Lake Victoria.

* * *

The Palolo Worm.

In a recent issue of our contemporary, the *American Naturalist*, Mr. W. McM. Woodworth gives an interesting account of the palolo worm of Samoa and Fiji. For more than half a century the appearance of swarms of these worms, apparently always just before the full moon, in October and November, has been familiar, and it has also been known that the worms forming these swarms are always imperfect. It is now ascertained that these palolo are the slender posterior generative portion of the annelid known as *Eunice viridis*, which at the swarming season becomes detached and free-swimming. This portion is very much longer than the proper body of the creature, which is, however, much stouter. The complete worm dwells in coral-reefs, into which it burrows; and, curiously enough, its existence there was quite unknown to the Samoans, to whom the demonstration of its presence by Mr. Woodworth came as a revelation. The worm only attains its full dimensions shortly before the swarming season.

* * *

A Precious Product.

According to a writer in the February number of the *Zoologist*, a lump of ambergris, weighing about 4½ lbs., was taken from the intestines of a male sperm-whale killed last June between Iceland and Norway, in about the latitude of Trondhjem; a very unusual resort, by the way, for cetaceans of this species. Ambergris, which is very largely used in perfumery, is solely a product of the sperm-whale, and appears to be a kind of biliary calculus. It generally contains a number of the horny beaks of the cuttle-fishes and squids, upon which these whales chiefly feed. Its market price is subject to considerable variation, but from £3 to £4 per ounce is the usual average for samples of good quality. Mr. T. Southwell, the writer referred to, states, on the authority of a correspondent in the sperm-oil trade, that in 1898 a merchant in Mincing Lane was the fortunate owner of a lump of ambergris weighing 270 lbs., which was sold in Paris for about 85s. per ounce, or £18,360.

* * *

African Insects.

Descriptions and illustrations of the entomological fauna of Tropical Africa are in course of publication in the *Annales* of the Congo Museum, issued at Brussels. In one of the two latest parts, Mr. A. Lameere describes the longicorn beetles of the sub-family *Prioninæ*, while in the other Mr. H. Schouteden writes on certain groups of flower-bugs. Both memoirs are illustrated by coloured plates remarkable for their beauty of execution.

* * *

Papers Read.

At a recent meeting of the Royal Society a communication was read on the pharmacology of Indian cobra-venom, based on experiments made by Captain R. H. Elliot, of the Indian Medical Service. On the 3rd of March, at the Linnean Society, Dr. J. G. de Mau described certain species of the crustacean genus *Palæmon* from Tahiti, Shanghai, New Guinea, and West Africa. The papers read at the meeting of the Zoological Society, held on March 1st, included one by Mr. R. T. Leiper on *Avagina incola*, a new genus and species of the *Proporidæ*, with a note on the classification of the group; and a second, by Dr. Einar Lönberg, of Stockholm, on two specimens of hybrid grouse of which the exact parentage is known. The papers read at the meeting of the same Society on March 15 comprised one by Mr. F. E. Beddard on the anatomy of lizards, one by Mr. Lydekker on certain points in connection with the skull and colouring of the extinct quagga; a second by the same author on the distinctive features of the Asiatic wild asses, respectively known as the Chigetai and the Kiang; one by Mr. R. J. Pocock on a new African monkey, and one by Mr. P. J. Lathy on additions to the list of Dominican butterflies (*Rhopalocera*).

Certain interesting specimens were exhibited at the Zoological Society's meeting on March 1. In the first place, Dr. Günther directed attention to hybrids between Reeves's pheasant and the silver pheasant. Next, Mr. Thomas exhibited the skull of a large buffalo killed by Colonel Delmé-Radcliffe in S.W. Uganda, which was believed to indicate a distinct local race of *Bos caffer*. The same gentleman also displayed a new species of fruit-bat from Fernando Po, remarkable for its small bodily size. Thirdly, Mr. J. G. Millard exhibited a collection of skins in illustration of the life-history of the grey seal, whose geographical distribution was discussed. A few other minor exhibits were likewise made.

XUM

Corrigenda.

Owing to an unfortunate oversight, the author of the article on the Ancestry of the Camel and writer of Zoological Notes in the March Number had no opportunity of revising the proofs; the following corrections are therefore necessary.

P. 25,	1st	Col.,	line	17	from	bottom,	for	*gazella*	read	*gazelle.*
,, ,,	2nd	,,	,,	20	,,	top	,,	*are*	,,	*is.*
,, 26,	,,	,,	,,	10	,,	,,	,,	*Linta*	,,	*Uinta.*
,, 27,	1st	,,	,,	26	,,	,,	,,	*Procamelas*	,,	*Procamelus.*
,, ,,	,,	,,	,,	4	,,	bottom	,,	*Plianchenia*	,,	*Pliauchenia.*
,, ,,	2nd	,,	,,	19	,,	,,	,,	*Camelas*	,,	*Camelus.*
,, 28,	1st	,,	,,	28	,,	top	,,	*Alticamelas*	,,	*Alticamelus.*
,, ,,	,,	,,	,,	25	,,	,,	,,	*Procamelas*	,,	*Procamelus.*
,, ,,	,,	,,	,,	8	,,	bottom	,,	*Paracamelas*	,,	*Paracamelus.*
,, 42,	,,	,,	,,	33	,,	top	,,	*Lada*	,,	*Lado.*
,, ,,	2nd	,,	1st	line			,,	*gulo*	,,	*Gulo*
,, ,,	,,	,,	line	35	,,	bottom	,,	*Malayensis*	,,	*Malayenses.*
,, ,,	,,	,,	,,	24	,,	,,	,,	*Parachiromys*	,,	*Metachiromys.*
,, ,,	,,	,,	,,	12	,,	,,	,,	*Soemmeringi*	,,	*sœmmerringi.*

BOTANICAL.

THE rare occurrence of stamens developing inside the ovary has been recently met with in a Caryophyllaceous plant, *Melandryum rubrum*, and is made the subject of a paper by Professor F. Buchenau in the *Berichte der Deutschen Botanischen Gesellschaft*, XXI. The material was collected in the neighbourhood of Marburg, Germany, having first attracted attention on account of the absence of petals. A closer examination revealed great irregularity in the structure of the ovary and in the number of the stigmas, and on making a section of the former it was found to contain six to nine, sometimes ten, well-developed stamens arising from its base, the central placenta, with the ovules, being altogether wanting. Dr. M. T. Masters, in his *Vegetable Teratology*, refers to a Myrtaceous plant, *Bæckea diosmæfolia*, in which a similar abnormality was found. The ovary contained no ovules, but numerous stamens, in various stages of development, were attached to the inside walls. In other respects the flower appeared to be quite normal.

The standard work on the flora of South Africa is, of course, the *Flora Capensis*, which was begun by Harvey and Sonder, and is being continued under the editorship of Sir W. T. Thiselton-Dyer. This work, of which a new part has just been issued, gives full descriptions, with synonomy and localities, of all the known flowering plants of Africa south of the tropics, and is necessarily bulky and expensive. Professor Henslow's *South African Flowering Plants*, lately published by Longmans, Green, and Co., will be welcomed by those who seek a handy inexpensive work on the South African flora, but who do not require the fulness of the *Flora Capensis*.

The very imperfectly known flora of Siam is being investigated by Mr. F. N. Williams, who has commenced an enumeration of the plants of this country in the last number of the *Bulletin de l'Herbier Boissier*. His work is based on the material in the Kew Herbarium. Collectors have paid very scanty attention to this flora, and several sets of plants, said to be from Siam, are shown to be from localities outside its boundaries, and cannot, therefore, be included in his enumeration. Some preliminary remarks on the flora were made by the same author in the *Journal of Botany* of September, 1903, where he mentions the interesting fact that the well-known commercial product, Siam benzoin, is obtained not from Siam but from a locality in the Lao province of French Indo-China.

PHYSICAL.

Chlorophane.

Chlorophane is the name given to those varieties of Fluorite (Fluorspar Calcium Fluoride), which possess to a noticeable extent the property of "thermo-luminosity," that is to say, of spontaneously emitting light when heated. The temperature at which this phenomenon takes place is not the same in all cases, but varies with different varieties of the mineral—the heat required being generally between 300° and 400° C. On first heating little or no light is emitted, until what may be called the "critical temperature" is reached, when the Chlorophane glows brightly and continues to glow for some hours after cooling to ordinary temperature, but more feebly. The colour of the light varies, blue and green predominating. Hagenbach found that the spectrum of phosphorescent Fluorite consisted of only nine bands, four blue, two green, two yellow, and one orange. As the relative intensity of these bands is continually changing, it is easy to understand the different colours presented by different varieties of this mineral. The pure white Fluorite does not possess the properties of Chlorophane, apparently the presence of some other salt or impurity is necessary, as in the case of phosphorescent Calcium Sulphide.

* * *

Chlorophane and Radium.

Madame Curie states (*Chemical News*, Vol. LXXXVIII., No. 2293, p. 223), that: "Fluorite when heated undergoes a change, which is accompanied by the emission of light. If the Fluorite is afterwards subjected to the action of Radium an inverse change occurs, which is also accompanied by an emission of light." This being so, what effect would be produced by first acting upon the Fluorite with Radium, and then applying heat? The following experiment was devised for the purpose of ascertaining this. A small crystal of Chlorophane was exposed for six hours at a distance of two millimetres from 10 milligrams of Radium Nitrate (Giesel's preparation) in such a manner that only the β and γ rays acted upon it. The initial fluorescence excited under these conditions was fairly bright, and persisted after removal but slightly diminished in intensity, and when kept at uniform temperature fell to half value in two to three days, dying down to negligible quantity in six to seven days. The changes in thermoluminosity were very marked, a very slight rise in temperature, such as that produced by placing the crystal in the palm of the hand, sufficing to increase the luminosity about 100 per cent. This increase is at the expense of the duration of retained fluorescence. The "Alpha" rays of Radium are without appreciable effect on Fluorite. Careful observations made with a Bismuth plate covered with a deposit of Markwald's Radio-tellurium (Polonium ?) of sufficient radio-activity to cause a piece of Willemite to glow brightly when in close contact, gave only negative results. It would be of great interest to know the exact nature of the change occurring in the chlorophane, whether it is of a chemical or physical kind.—*Ernest L. Armbrecht, M.P.S.*

[N.B.—The writer also finds that the above properties are not confined to Chlorophane, but are also shown by Kunzite, with which very pretty experiments may be made on above lines.]

* * *

Wireless Telegraphy Experiments between Germany and Sweden.

The Berlin Gesellschaft für Drahtlose Telegraphie some time ago installed two wireless telegraphy stations on the Norwegian Loffoden Islands, the two points chosen being 50 km. distant and separated by high continuous rocky masses, so as to oppose serious obstacles to the passage of the electric wave. These stations were designed for dry cell operation, in order to ascertain whether communication over distances as high as 50 km. would be possible with such small amounts of electric energy. This, however, was found not to be the case as the primary energy of a limited number of dry cells proved insufficient, a consumption of about 200 watts being necessary to overcome the obstacles on the passage of the electric waves.

The experiments between Germany and Sweden, as contemplated for some time past, were begun on December 16th, when wireless telegraphy communication was secured between Oberschönweide, near Berlin, and Karlskrona, a Swedish naval station, over a distance as high as 450 km. The results so far obtained are said to be quite satisfactory.

The "Telefunken" system used is a combination of the Braun and Slaby-Arco schemes which, we learn, is being frequently used with the Swedish Navy.

* * * *

The National Physical Laboratory.

ONE of the prominent even tsof the past month was the annual visitation and inspection of the important standardizing and testing laboratory at Bushey House, Teddington. Erstwhile a Royal domicile, the mansion and adjacent buildings are now

devoted to experimental work designed to promote the joint interests of the nation's manufacturing industries (in the conduct of which applied knowledge is requisite) and theoretical inquiry of a scientific character. Probably few of the general public who visit Bushey Park in such numbers are aware of the proximity of the National Physical Laboratory, still less of its aims, although it is a public institution maintained by means of the taxpayers' money. Here, however, a great work is unobtrusively going forward, whose benefits spread themselves far and wide. Many and varied are the investigations pursued. In electricity, for example, is one on the effect of temperature on the insulating properties of materials used in dynamos, motors, and transformers; in thermometry a research on the specific heat of iron at high temperatures; in metrology, the standardization of the steel yard and nickel metre; and in metallurgy a series of tests on nickel steel. Then, in the department of engineering, experts say that the inquiries in hand are eminently useful to a producing country such as England is, and hopes to remain, despite her foreign competition. Comprised in electrotechnics are tests on electrical instruments, ammeters, wattmeters, voltmeters, and other indispensable adjuncts to the needs of industry. Again, in chemistry, optics, and photometry, the record of investigation bears the same tendency.

The laboratory is, of course, a young organisation as yet; but its operations are ramifying in all directions under the able guidance of Mr. R. T. Glazebrook, F.R.S. But, as Lord Rayleigh, the Chairman of the General Board, pointed out the other day, unless adequate funds are provided to meet the national purposes of the foundation the institution must fail in accomplishment, and a starved laboratory would probably prove a worse evil than none at all. Besides, it should be borne in mind that Paris and Washington have recently followed the example of London in initiating standardizing establishments intended to help national industries each, too, is subsidised in a far more liberal way than in our own case. The necessity for making better provision for the needs of the laboratory has lately engaged the earnest attention of the Executive Committee, and representations have been made to His Majesty's Treasury on the subject. A detailed scheme for the future organization and development of the institution has been drawn up and submitted. This, if approved, will entail a revision of the existing Parliamentary grant-in-aid, but in view of the special functions of the laboratory, and the sphere of usefulness that lies before it, strong hopes are entertained of a favourable issue to the appeal.

CORRESPONDENCE.

A Novel Electric Traction System.

TO THE EDITORS OF "KNOWLEDGE."

SIRS,—The scheme described under the above heading in your March issue, taken from the *Electrotechnischer Anzeiger*, presents such curious features that one is inclined to doubt whether it has been put forward seriously. To use electrically-heated steam-engines in preference to electric motors would appear, at any rate at first sight, as an absurdity, as the following considerations will show.

It may be safely assumed that the internal thermal efficiency of a steam locomotive does not exceed 10 per cent., *i.e.*, only 10 per cent. of the thermal energy carried by the steam from the boilers into the cylinders is converted into work on the piston. So that, accepting 90 per cent. as the efficiency of the electric heaters, and assuming the mechanical efficiency of the engines to be as high as 90 per cent., it follows that of the electrical energy supplied to the boiler all that is available for propulsive power is 90 per cent. of 10 per cent. of 90 per cent., *i.e.*, about 8 per cent. Against this the ordinary electric locomotive would have, as stated in the article, an over-all efficiency of 60 to 70 per cent., or even more.

Now although the actual energy for a water-power installation in a sense costs nothing, the plant to develop it is very costly; and it may be safely predicted that it would not pay to use a generating plant and transmission system eight or nine times too large to save scrapping the steam locomotives.

This very large ratio against the electro-thermal system would, it is true, be reduced by the fact that every locomotive would to some extent act as an equaliser of the demand on the power-houses, reducing the excess plant that would have to be installed; but the larger system worked from one power-house, the less this advantage would become; and in any case the excess of power required by the electro-thermal system would be enormous.

Even if under any conceivable conditions such a system might prove advantageous, it is certain that the figures put forward to justify the proposal are entirely erroneous; and this confirms one's doubts as to the scheme having emanated from any authoritative quarter.

The first point to be noted is that it is proposed to raise the temperature of the water from 10° to 190° C., requiring 180 calories per kg.; but 190° C. is said to correspond to a steam pressure of 50 kg. per sq. cm. As a matter of fact, 190° C. (= 374° F.) corresponds to saturated steam at about 170 lbs. per square inch (above atmosphere), whilst 50 kg. per sq. cm. is equivalent to 710 lbs. per square inch. However, as pressure is not referred to further by the writer this discrepancy does not matter much.

But next it is said that to raise 4000 litres of water through 180° C. will take $4000 \times 180 = 720{,}000$ calories; this is true if it remained water, but this amount of heat is by no means enough to convert the water into steam, *i.e.*, to provide the so-called latent heat of evaporation. So that, whilst it might be correct to say that a consumption of 1000 kg. of hot water per hour at 190° C. would take 225 kilowatts, it is very far from the truth to say the same of 1000 kg. of steam.

To convert 1000 kg. of water at 10° C. into steam at 190° C. will take, not 180, but about 635 calories per kg.; in other words, 635,000 calories per hour must be provided; and if 1 calorie in the boiler requires 1·275 watt-hours, the electrical energy will have to be supplied at the rate of 810 kilowatts, or more than three-and-a-half times the figure given.

An electric locomotive taking 810 kilowatts might be relied upon to give 700 to 900 effective horse-power; the electric steam locomotive taking the same electrical power, and evaporating steam at the rate of 1000 kg. per hour, would not give more than 100 to 125 effective horse-power, if so much.

Your obedient servant,
ARNOLD G. HANSARD.

53, Victoria Street, Westminster, S.W.,
March 9, 1904.

Snake Stones.

TO THE EDITORS OF "KNOWLEDGE."

SIRS,—Some time ago I was much interested in a series of articles in the scientific column of a weekly paper on the subject of "Snake Stones." Nothing was said at the time in connection with Brazil, and as I lived in that country for several years it may be interesting to some of your readers to have a word on the subject. "Snake stones" are not stones at all, at any rate not in Brazil, and I should think they would be much the same all over the world. In the articles above referred to there appeared to be great doubt as to what they are. The only ones used in the part of Brazil where I was were made from the horns of young deer, burnt or carbonised in a peculiar manner, which leaves it very suctorial, and which is kept as a close secret by a very few men who make them for sale or barter, and try to make out that they have almost supernatural power to heal snake bites. They are usually sold in pairs, and are not by any means common. In form they are about one inch in length, four-sided, and slightly tapering to one end. When anyone is bitten by a snake, one of these "stones" is placed on the spot and held close, while a band of some sort is tied tightly round the limb a little way back towards the trunk. The "stone" is allowed to remain on the wound until its own weight makes it fall off, when it is presumed all the poison has been extracted. It is then dropped into milk and allowed to soak. It is said that if the person is to get healed the milk will turn to a dark brown colour, the fact being, I suppose, that the blood held by the stone has that effect. As usual with these things, there are many superstitious beliefs in connection with these "stones,"

XUM

and the cure is supposed to be miraculous; whereas I suppose that it is really due to the great capillary attractive force they possess, which extracts a certain amount of blood, and with it the poison. After being thoroughly washed out and dried they are ready for another occasion. Yours truly,

JAMES SEARLE.

[Some experiments recently made in the Government Bacteriological Laboratory of Natal have shown that the mysterious curative properties ascribed to snake stones are quite illusory.—Editor.]

The Ancestry of the Elephants.

SIR,—In the very interesting article on the above subject by Dr. Smith Woodward in the February number, I notice that he calls the fig. No. 6 on p. 13—(Head of *Tetrabelodon angustidens* restored)—a fanciful sketch. As a matter of fact, there has been introduced into it a series of circular wrinkles evidently copied from those on the proboscis of the African elephant figured just above it. But it is clear that, as this proboscis was not pendent, no such wrinkles would appear. Moreover, it would seem more probable that its form would not be circular, but rather shaped to fit the elongated chin.

In that case the mouth would act as a long pair of leathery tweezers, very suitable (with the help of the incurved tusks) for gathering in large mouthfuls of long, quick-growing marsh vegetation. The sharp incisors would enable this to be quickly cut off, and the ponderous animal could without delay move his weight on to firmer ground to masticate the food at leisure.

As the species moved further north to harder ground and tougher vegetation, a more prehensile grip would be useful rather than a speedy way of gathering food together, whereas the incurved tusk and elongated mandible would not only be useless but highly inconvenient. Thus as the proboscis became longer and rounder, the lengthened chin disappeared entirely; and the mammoth with its highly developed molars was able to subsist even on the hard and tough vegetation within the Arctic Circle.

HERBERT DRAKE.

Verwood, Dorset, February 26, 1904.

REVIEW OF BOOKS.

Animal Studies, by David Starr Jordan, Vernon Lyman Kellog, and Harold Heath. (New York and London: Appleton and Co., 1903.) This admirable little treatise is one of the "Twentieth Century Text Books," and bears a very close resemblance to the volume on "Animal Life"—also of this series by the same authors—reviewed in the columns of "KNOWLEDGE" in 1901. It differs indeed, mainly, in the addition of several chapters on Classification; and on the economic value and past history of animals. As an elementary text book of Zoology it must take high rank among works of its kind, and will doubtless find a ready sale in this country. Here and there, however, great opportunities have been missed, and more or less serious mistakes are made. Thus, in the chapter on the Classification of Birds, the auks and puffins are placed with the grebes and divers, the authors having been apparently led astray, like the older systematists, by the curious structural resemblance which these birds present in common. As a matter of fact, however, the resemblance to the grebes and divers which the auks, puffins, and guillemots present are entirely adaptive. Their nearest relatives are, without question, the plovers and gulls. So, too, with the gulls and terns, these have nothing whatever to do with the petrels and albatrosses with which they are associated in this book. The resemblances which they severally present are again adaptive. It is equally misleading to place the owls with the accipiters. Turning to the mammals, we may remark that, as with the birds, the classification adopted is antiquated. Nevertheless, in spite of the defects to which we have drawn attention, the work is one which we can heartily commend.

Pictures of Bird Life, by R. B. Lodge (Bousfield), illustrated; 27s. 6d. net.—Mr. R. B. Lodge has produced a most delightful book. The illustrations, which are very numerous, are all reproduced from his own photographs of birds and their nests taken from life. We see many such photographs nowadays, but none better than those reproduced in this book. There are eight full-paged plates reproduced by the three-colour process from photographs coloured by hand. We must confess that we would sooner have had these photographs without the colouring, which, in most cases, is not altogether true to Nature. The letterpress is interesting, and often very informing. Mr. Lodge has made the most of his opportunities, and tells us how and where he obtained his photographs. He has photographed birds in the Dutch marshes, Spanish marismas, and Danish marshes and forests, and in many places in England besides. He gives many valuable hints to those who would take up bird-photography, and describes several ingenious devices and tricks which he has himself used with success. The most notable of these is his automatic electric photo-trap, whereby he traps the bird's portrait by hiding the camera and inducing the bird by bait or otherwise to touch a piece of silk, and thus set an electric battery at work to release the shutter of the camera. Many of Mr. Lodge's observations on the habits of the birds which he has watched so long and so closely while trying to secure their portraits are most valuable. He may not have discovered much that was unknown, but his remarks are the result of direct and careful observation, and this can never be without great value. There are several repetitions in the book which might have been avoided by more careful editing. The sentence, "The Hooded Crow I do not remember seeing so far south" (Enfield) (p. 124), might be put in a less ambiguous form. The bird is, of course, to be seen commonly further south than London. Mr. Lodge will find that the vibratory noise made by woodpeckers is heard not only in the spring (p. 138). But these are only small points, and are only mentioned in view of a possible second edition of this excellent book.

BOOK NOTICES.

The Grant and Validity of British Patents for Inventions, by James Roberts, M.A., LL.B. (John Murray, one vol.; price 25s.). This work has been written for and from the point of view of the inventor. It is intended to enable him to confine his claims to what can be supported and to avoid errors in his specification. The first part consists of the principles and rules affecting the grant and validity of British patents, and the practice respecting the amendment of specifications both before the Comptroller-General and the Law Officers of the Crown; the second part of abstracts of cases, illustrating the application of these principles; and the third part, the statutes and rules. The scope and tenour of the book are such as to make it useful to practising lawyers as well as to inventors.

Mathematical Crystallography, by Harold Hilton, M.A. (Oxford: The Clarendon Press). Mr. Hilton's expressed purpose is to collect in this volume those results of the mathematical theory of crystallography which are not provided in the modern text books on that subject in the English language. He includes a valuable summary of the geometrical theory of crystal structure which the labour of Bravais Jordan, Schneke, Fedorow, Schoenflics, and Barlow have now completed. It is a student's book; an advanced, but an extremely valuable one.

Zoology, Descriptive and Practical. (Two Vols. D. C. Heath; price 4s. 6d. and 2s.)—The general plan of the volumes is to introduce each of the larger groups of animals by a careful study of a typical representative.

BOOKS RECEIVED.

The Naturalist's Directory (L. Upcott Gill):—Introduction to the Study of Physical Chemistry, by Sir William Ramsay—a wholly admirable allocution to students. (Longmans, Green.)

Martin's Up-to-Date Tables of Weights and Measures. (T. Fisher Unwin.)

Modern Navigation, by W. Hall, R.N. (Organised Science Series.) University Tutorial Press.

Second Stage Botany, by J. M. Lowson. (Organised Science Series.) University Tutorial Press.

Entropy, by James Swinburne. (Constable.)

The Model Engineer Series.—X-rays, Simple Experiments in Electricity, The Locomotive, Acetylene Gas. (Percival Marshall.)

A School Geometry. Parts I.-IV., by H. S. Hall; IV. and V., F. H. Stevens. (Macmillan.)

We have received from Messrs. Nalder Bros., of Westminster, their catalogue of **Electrical Testing and Scientific Instruments.** The catalogue is, in itself, an extremely interesting summary of the investigations now being carried on in various departments of research, and special attention may be directed to the photometric apparatus.

The following books are in preparation at the Clarendon Press:—

Suess' "Das Antlitz der Erde," authorised English translation, by Dr. Hertha Sollas, edited by Professor W. J. Sollas, with preface by Professor Suess for the English translation. Royal 8vo.

"Index Kewensis Plantarum Phanerogamarum." Supplementum secundum. 4to.

Goebel's "Organography of Plants," authorised English translation, by I. Bayley Balfour, M.A., F.R.S. Vol. II. Royal 8vo.

Mr. Henry Frowde will also publish shortly:—

"A History of the Daubeny Laboratory," by R. T. Günther.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Royal Microscopical Society.

February 17, Dr. Henry Woodward, Vice-President, in the chair. An old microscope by Bate was exhibited, probably made early in the last century. Mr. Stringer contributed a paper on an attachment for reading the lines in a direct-vision spectroscope, and Mr. E. M. Nelson a paper on the vertical illuminator. The author said that, after lying in abeyance for 25 years, the vertical illuminator had lately come into notice for the examination of opaque objects, and especially for the microscopical examination of metals. He criticised the four forms of this apparatus at present sold, namely, those known as the Tolles, Beck, Powell, and Reichert forms, and said that a vertical illuminator must not be an oblique illuminator, but must be capable of illuminating the full aperture of the objective with a parallel beam of light. It must not impair the use of the objective for ordinary work, and must, therefore, not be a permanent attachment. The reflector must be placed near the back lens, and there must be some method for regulating the illumination. Mr. Nelson found that the Powell form, which, like Beck's, consists of a nosepiece containing a reflector, more nearly conformed to these conditions, but the reflector should be made much larger and the hole in the side of the nosepiece should be as large as the Society's gauge. To obtain the best advantage with vertical illumination oil-immersion objectives should be used. The distance from the source of light to the mirror and thence to the objective should be equal to the distance from the eyepiece to the objective. At the hole at the side of the nosepiece there should be a carrier for diaphragms of various sizes in preference to a wheel of diaphragms or an iris. There should also be a strip of metal with a slit in it which could be drawn across the hole in the nosepiece, and the direction of the slit should be in a line with the edge of the flame of the microscope lamp. Another paper by Mr. Nelson, "On the Influence of the Anti-point on the Microscopic Image Shown Graphically" was also read. The author referred to a paper in the *Journal* for 1903 on "A Micrometric Correction for Minute Objects," wherein he stated by way of illustration that, if one of the minute spinous hairs on a blowfly's tongue was examined on a bright ground and on a dark ground, a considerable difference in the sizes of the two images was discernible, and that the difference was caused by anti-points. A table was also given showing the amount to be added to the micrometric measurement of the image seen on the bright ground to bring it up to its true value. Mr. Gordon, who had originated the theory of the anti-point, had made accurate drawings of the two images of the hair, and the ratio of the breadths of the hair in the drawings was as 45 to 65. Applying the corrections given in the table to the measurement of the apparent size of the hair on a bright ground, the actual size works out to 12 per cent. more. A difference in the apparent size of objects when viewed on a bright or dark ground was recognised many years ago, but never explained, but Mr. Gordon's admirable anti-point theorem has unlocked the riddle. Mr. Keith Lucas followed with a paper "On a Microscope with Geometric Slides," the principle enunciated being applied by the author of the paper to the fine and coarse adjustments and to the sub-stage of a microscope, which was illustrated by lantern slides.

The Quekett Microscopical Club.

The annual general meeting was held on February 19 at 20, Hanover Square, the President, George Massee, Esq., F.G.S., in the chair. After the usual business had been transacted, a ballot was taken resulting in the election of Dr. Edmund J. Spitta, F.R.A.S., as President for the ensuing year. Mr. Frank P. Smith was elected Editor in succession to Mr. D. J. Scourfield, and Mr. Arthur Earland, Secretary. Dr. G. C. Karop, who has held the secretaryship for over twenty years, goes into well-earned retirement, carrying with him the gratitude and esteem of all the members. The other officers were re-elected.

The President delivered his annual address, dealing with the commoner fungoid diseases of garden trees and plants. These may be divided into two groups, according to whether the mycelium of the fungus is situated in the woody tissues of the plant ("perennial mycelium"), or whether only the season's growth, the leaves and fruit are affected. The first division, of which the well-known "peach-curl" is an instance, is by far the more serious of the two, it being practically impossible to cure a plant which has become badly infected. In the second division, the plant becomes automatically purified, for a time, on the removal of the infected leaves, &c., either artificially or in the course of nature, and if suitable measures are taken to prevent the germination of the spores in the following season, the plant may be wholly cured. Fire is the best destructive agent; the infected leaves should be burned. Spraying is ineffectual, for the mischief is under the surface, and spraying tends to spread the disease to fresh hosts by washing the spores off the infected plants.

The chief causes of fungoid disease in cultivated plants are overcrowding and the use of chemical manures, which kill the nitrifying bacteria of the soil and stimulate the plant to an excessive and weakly growth.

After the usual votes of thanks, Dr. Spitta was installed in the Presidential Chair, and in returning thanks for his election, referred to the analogy between the fungoid diseases of plants and the zymotic diseases affecting man, especially typhoid and diphtheria.

It is an open secret among microscopists that the Quekett Club's position at 20, Hanover Square has lately been somewhat precarious, owing to the general rise in rents and the keen demand for accommodation in the building of the Royal Medical and Chirurgical Society. I am therefore glad to be able to say definitely that the Committee has succeeded in obtaining an extension of their tenancy in their old quarters, with retention of all their present accommodation, though at a considerable increase of rent, which will, I trust, be justified by a corresponding increase of membership. To the amateur microscopist, especially the Londoner, the Quekett Club, with its very low subscription of 10s. per annum, without entrance fee, offers many advantages. The announcement was made at the annual meeting that a new catalogue of the Club's fine library of about 1300 volumes was in course of publication, and this should still further increase the popularity of the Club. Applications for membership and inquiries relating to the Club should be addressed to the Hon. Secretary, Mr. A. Earland, 31, Denmark Street, Watford, Herts.

XUM

The Journal of Applied Microscopy.

I am informed by Messrs. A. E. Staley and Co. that the American *Journal of Applied Microscopy* will be discontinued after the appearance of the November and December numbers of last year. This is a matter for sincere regret, as the journal, though distinctly technical, was a really valuable one, and it is unfortunate that it should not have met with sufficient support to justify its continuation. We are none too well supplied with microscopical literature, and it is strange that endeavours to provide for our deficiencies in this respect do not meet with more support. I fear that in the case of the journal referred to, the unfortunate and recurring arrears of publication, due, I believe, to the regrettable illness of the Editor, was responsible for the loss of no little support. Those of our readers who may wish to complete their sets may be glad to know that Messrs. Staley have a large number of back numbers in stock, and will be pleased to send them to any subscribers for the sum of 2d. each.

New Pond Life Tanks.

Messrs. Flatters and Garnett, of Deansgate, Manchester, have sent me for inspection a new tank for the study of pond life. It is made of one solid piece of glass, and is not unlike an ordinary large goblet with flattened sides and square corners, standing on the usual round stem and foot. The sides are polished on the outside to prevent the usual distortion due to the unevenness of glass, and the depth from front to back is such that an ordinary pocket lens can be conveniently used. The size of the tank sent to me was 4¼ inches high, 4 inches wide, and ⅞ inch deep, and it was very steady. Leakage was of course impossible, the tank was easy to clean, and the price very moderate—namely, 3s. 9d. I understand these tanks are made ¾ inch high, 1½ inch wide, and ¾ inch deep at about half the price of the stand mentioned above, and also in a larger and more elaborate form, lined with opal glass and mahogany frame at the ends and bottom.

Preserving Orthoptera.

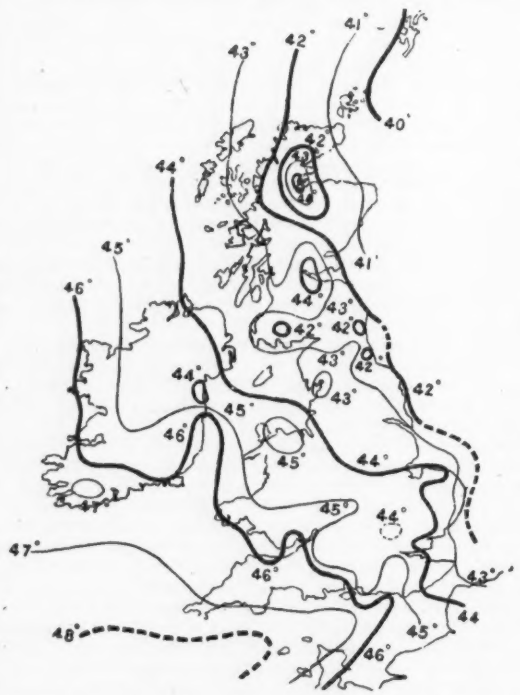
Mr. J. W. Williams, M.R.C.S., F.L.S., writes to me, in connection with the note last month on preserving orthoptera, that he has found dipping the specimens into a weak solution of albo-carbon in benzole is a better preservative against mould than the carbolic acid plan therein suggested, and a better curative also for mouldy specimens. Mr. Williams says he has tried this plan consistently with satisfactory results.

Chess Column.

WITH reference to our note last month requesting opinions on this subject, we have to state that, having only received nine replies, of which seven were in favour of the retention of the Chess Column, we feel that the subject is not one of sufficiently widespread interest to warrant our devoting the space to it, and, therefore, we must, for the present at all events, discontinue the Notes and Problems.

LAST YEAR'S WEATHER—APRIL, 1903.

DISTRIBUTION OF MEAN TEMPERATURE.



The general distribution over Scotland differed from the normal, the isotherms having a north and south direction instead of west and east. Elsewhere the differences were less marked. The actual values were, without exception, below the average the deficiency as a rule being from 2° to 3½°.

RAINFALL.

Rainfall was very irregular both as regards the quantity and the frequency, there being localities of excess and of defect in each district, some stations having twice as many days with rain as others in the same neighbourhood.